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THE R. A. F. PENROSE, JR., MEMORIAL LECTURE

AN INFERENCE REGARDING THE EXPEDITION OF LEWIS AND CLARK

BERNARD DeVOTO

(*Read April 21, 1955*)

I AM grateful to the American Philosophical Society for the privilege of appearing here tonight, and of discussing an event with which the Society was so closely concerned, important memorials of which are in its possession. I have worked here on the manuscripts that constitute the basis of what I shall be saying in a moment, with an exciting awareness of history's continuities that the materials of the historian's trade have not otherwise given me. It is a satisfaction to associate myself with one of those continuities tonight by discussing the expedition whose author was an illustrious member of the Society and the donor of the manuscripts mentioned.

I must begin with an embarrassing circumstance. A person who talks about the Lewis and Clark expedition at this moment is in a situation not unlike that of one who owns a house on the bank of a river which is in flood. Part of his foundation may be undermined and some of his structure may collapse.

Some time ago a number of previously unknown documents written by William Clark and bearing on the expedition were discovered. They came into the possession, though perhaps only the temporary possession, of the Minnesota Historical Society. Quite properly, they have been withheld from the scrutiny of students till the question of who own them is settled, and till a scholar designated by the Historical Society has completed an appraisal of their importance. One who talks about the expedition, therefore, must exercise the fullest measure of scholarly caution, not to say caginess.

Yet it is true, too, that at times a scholar must rise above ignorance. I do not mind guessing about the bearing of these new documents on our understanding of the Lewis and Clark expedition. One of them is a series of brief but consecutive notes by Clark covering the upriver journey from St. Louis in 1804. Quite surely, the documentation which we now have in manuscripts owned by this Society, and in other collections, is far more complete than any the new discovery can provide. Yet it is possible that the new notes may contain details of great interest and may provide information that will solve some existing problems.

Other manuscripts are more provocative to the student's imagination. The party spent the preceding winter, that of 1803–1804, in camp opposite St. Louis, on the American shore of the Mississippi. We have little knowledge of what happened during that time, in camp or on the visits of Lewis, Clark, and other members of the party to St. Louis and other places. For most of the period, in fact, we have had no knowledge at all. Apparently, the new discovery will help to fill this gap, though in how great detail one cannot tell. There is a kind of daily log, apparently similar to the daily notes from which the daily entries in the journals were written after the party started up the Missouri, but apparently also much abbreviated. There are other manuscripts of this winter as well but I cannot guess about them.

It is unlikely, indeed it seems impossible, that the new documents will produce any change in our understanding of the purposes of the Lewis and Clark expedition, or necessitate any change in our appraisal of its achievements. They are not of that order of importance. Their potential importance would appear to be for specialists only. I note sorrowfully that few historians have cared to become specialists in the expedition, and the fact that so few have cared to is responsible for most of the uncertainties that I shall presently take up.

Let us glance at some of the possibilities one attributes to the newly discovered manuscripts. They may contain, or may make it possible for students to work out, a dependable roster of the party. For in spite of the official journals and memoranda, in spite of Nicholas Biddle's *History*, and in spite of the researches of scholars, we are not certain how many members the expedition numbered from St. Louis to its winter encampment, Fort Mandan. Some students, though I am not one of them, profess to be uncertain how many it numbered on the journey from Fort

Mandan to the mouth of the Columbia. There may also be clues, perhaps clues that would in the end prove conclusive, to the solution of an important mystery, our failure to solve which is most mortifying. Congress appropriated $2,500 to cover the expenses of the expedition. Quite clearly it must have cost more than the appropriation, but how much more has not been determined, nor how the additional costs were allocated, nor which department of the government paid them. Evidently too the lists and inventories so far known do not cover in full the equipment and supplies of the expedition, or the amount of goods it carried for presents to the Indians and barter with them. (For example, the known amount of gunpowder is inadequate to supply so large an expedition, absent so long from any source of supply, hunting so constantly and on so large a scale, and so lavish in gifts of ammunition to the Indians.) If the new documents contain memoranda of drafts issued by Lewis or purchases made at St. Louis, Cahokia, and perhaps elsewhere, they will be exceedingly welcome.

Other possibilities are probably of a lesser order. For instance, can the description of the keelboat and the pirogues be amplified? Did the captains meet James Mackay, the former North West Company partner, in person, and if so where and on what occasions? It is known that they had notes by Mackay but did they have a copy or a summary of his journal of his voyage up the Missouri? Is there further information about the fur-trader, John Hay, or about his visit to the winter camp? Is any additional light cast on the desertion of the boatman who was apparently named La Liberté? Are there additional details about the illness and death of Sergeant Floyd? Questions of this kind may be answered by the new documents, and the specialist will be jubilant if they are. But to the student or practitioner of history in general such questions do not matter much.

We do not know as much about the Lewis and Clark expedition as, considering its importance, we ought to know. Worse still, what is known about it is sometimes not fully understood by our general historians. Surely this was the most important exploring expedition in our history. Unquestionably it had massive importance for various domestic policies of the United States and even more massive importance for our foreign policies. We might, therefore, expect it to bulk larger in general history than it usually does. We might also expect historians of the frontier, of the West, of expansion, and of diplomacy to examine it more carefully than a surprising number of them have done. I cite a single example, typical of many. A statement has stood uncorrected through successive editions of a work whose scholarship in general is sound and which is accepted as an authoritative history of the early Northwest, a statement that the boats of the expedition were pulled up the Missouri by horses, as if they were canal boats and there were towpaths on the banks.

Now this is an infinitesimal misconception, of no importance whatever in itself, but consider what it implies. No one who has read either the *Journals* or Biddle's *History* could make the statement, for almost every daily entry shows how the boats were in fact propelled, and that was never once by horses; indeed there were no horses for such a purpose. But the importance of the expedition cannot be understood, I tell you in fact that even the nature of its importance cannot be perceived, unless those volumes are studied minutely and with every instrument of appraisal the historian can use on them. A historian who reveals that he has not studied them is also revealing an implicit judgment on the relation of the expedition to American history, a judgment which is at a great remove from the realities. He reveals that he is approaching it by means of assumptions adopted from general history. Those assumptions, with their implicit judgments, have become traditional. The remarkable fact is that at no time during the last generation have they been critically scrutinized. The slow, and I grant small, accumulation of knowledge through half a century has not been brought to bear on them. When they are critically examined in the light of that knowledge, they not only fail to explain the expedition, in my judgment, but become profoundly deceptive.

My assertion here is twofold. On the one hand, remarkably little scholarly research has been devoted to the Lewis and Clark expedition, and as a result we know less about it than we urgently need to know. On the other hand, we have widely failed to understand important significances in what we do know about the expedition, because the traditional assumptions, made long ago, are superficial and of faulty orientation.

I proceed to discuss several forces which, if my analysis is sound, have been in part misunderstood, in part dismissed as less central than in fact they were, and in part disregarded. What I say is largely inferential and conjectural. Prop-

erly controlled, inference and conjecture are valuable tools of history; in fact, history cannot be practiced without them. They are customary tools in such fields as this one, whose edges are indistinct, and they are especially appropriate on such occasions as this evening, when the purpose is not to provide new knowledge but to discuss existing knowledge. And you will see that inference and conjecture play a smaller part in what I present to you than re-examination of facts whose solidity is not open to question.

The definitive plans for the expedition of Lewis and Clark were made during a world war. The United States was trying to keep out of the war but might be forced to enter it to defend its national interest, or might become involved in it through aggressive action by France or Great Britain, or less conceivably Spain. For the time being hostilities in Europe had ceased but the armistice, which was called a peace, was known by everyone to be only a pause for the realignment of alliances and the regrouping of forces. The American government knew that the peace was self-limited. The war had extended to the Western Hemisphere when Napoleon set out to reconquer Santo Domingo from its dictator, Toussaint l'Ouverture. Santo Domingo was a strategical key to military action in the Western Hemisphere, and therefore to the defence of the United States. Moreover, the attack on Santo Domingo was linked to international action even more menacing to the United States, the repossession, currently delayed but soon to be completed, by France of the vast, almost unknown area called Louisiana, which was separated from the United States only by the Mississippi River. Louisiana was ceasing to be the possession of a decadent, militarily impotent nation and becoming the possession of the most powerful and aggressive nation in the world, a nation ruled by a dictator who manifestly intended to restore and enlarge the French Empire in North America.

The cession, or as diplomacy called it the retrocession, of Louisiana had forced on our government a recognition that was distasteful to the President who accepted it so realistically. Jefferson's distrust of Great Britain was lifelong but he was, as well as President, the first American master of what today we call geopolitics. The cession forced him to recognize the geopolitical reality that was to be eventually formulated as the Monroe Doctrine—to recognize an inherent community of interest between the United States and Great Britain in the defence of the Western Hemisphere against European aggression and expansion. The cession had also made more urgent the necessity, which had always been recognized, of acquiring for the United States some kind of foothold at another geopolitical key point, the mouth of the Mississippi.

These were the urgencies that initiated the effort to buy the Isle d'Orleans which ended in the purchase of Louisiana. More must be said about the Purchase presently, but for the moment focus on the urgency. As a gauge, let us suppose that at this moment in history Canada had somehow become a Russian possession.

Nevertheless, the Lewis and Clark expedition was definitively planned before the beginning of preparations for the purchase of the Isle d'Orleans, and it had been intended since long before it was concretely planned. Exactly what was the expedition? It was an exploring expedition which was to cross Louisiana and go on to the mouth of the Columbia River. Let me phrase the same fact in different words: it was to cross foreign territory, and it was to reach an area to which the United States had a basic and valid if untested claim according to the usages of nations. The area it was to reach was a prime source of the principal exterior commerce, and therefore the principal external wealth, of the United States.

To weigh this fact accurately, we must lift it out of the matrix in which it was set. That is an arbitrary act, for of course it cannot be separated from all the other facts that went to produce the expedition of Lewis and Clark, but it is necessary. Say simply that the expedition was to cross Louisiana and go on to Oregon. (The area was not yet called Oregon but we may anticipate the christening.) I repeat that we have two elements here: it was to cross Louisiana, and it was to reach Oregon.

Both the route and the destination were fundamental, but I suggest to you that our traditional emphasis has been wrong. The expedition has been thought of as primarily dispatched to cross Louisiana. I believe we must emphasize that it was dispatched to reach Oregon. If one element must be given greater weight than the other, in my judgment it is Oregon.

Other observations must be made at once. We may delight in a historical continuity. The expedition was directed to discover an inland water route across the land mass of North America to the Pacific Ocean. It was directed to do so in the way that must be called classical. It was to ascend the still largely unknown Pekistanoui River

of Jolliet and Marquette, the Missouri. And it was to go on from the sources of the Missouri to a river that was a little known at its mouth and so far as known misunderstood, the Columbia, which had inherited the aura of hypothesis, legend, and myth associated with the symbolic Great River of the West. Thus the expedition was another essay in an effort that had endured throughout the history of the expansion of Europe in the Western Hemisphere. It was another search for the Northwest Passage.

But also the expedition was a project of Thomas Jefferson, who was impelled toward it not only by his obligations as President but by the bent and burden of his thinking ever since boyhood.

We need not emphasize certain facts that bear on Jefferson's cardinal thesis as our first geopolitician, but we must mention them. He had grown up in what it is proper to call a society of the western frontier. He had been surrounded by actual explorers of the western wilderness, one of them his father, and by thinkers who believed that the Western wilderness would shape the destiny of the North American people. What we call "expansionism" had always been familiar to him as a principle and an energy. At the age of fourteen he had come under the tutelage of a philosopher of expansionism, James Maury. As early as the outbreak of the French and Indian War, Maury had declared a thesis: whichever nation held the water routes of the Great Lakes, the Ohio River, and the Missouri must become the dominant power in North America and would control the trade with the Orient. When Jefferson was elected President, he took to Washington as his private secretary another student of Maury's whose principal qualifications for the secretarial position were his experience in the western wilderness and his intense ambition to cross it to the Pacific. The secretary's name was Meriwether Lewis.

Jefferson had always understood that the progress of expansion required exploration and discovery. We need mention only two actions he had taken to promote them. In 1783 he proposed an exploration of Louisiana to George Rogers Clark, the famous frontier leader who was the older brother of William Clark. Ten years later, in 1793, as a member of a committee of the American Philosophical Society, he shared the sponsorship, financing, and preparation of an expedition headed by André Michaux that was to explore Louisiana—by ascending the Missouri—and to go on to the Pacific. Note that both actions followed augmentations of British interest in the western wilderness. Jefferson saw contention between the United States and Great Britain for this wilderness as geographically and economically implicit, as in fact it was. No doubt its importance to him was intensified by his distrust of England.

The expedition which actually made the exploration was that of Lewis and Clark. By the time Jefferson began to prepare it, events had occurred of decisive importance to the American-British contention for the West. Come back to the basic fact. The expedition was to cross Louisiana, which was foreign territory, the possession of a foreign and aggressive power, an area to which the United States had no claim of any kind. And it was to go on to Oregon, an area to which the United States had a valid but untested claim, an area in which American commerce of great value was carried on, and an area for the ultimate possession of which there was implicit contention between the United States and Great Britain.

We must now bring to bear on our problem the decisive events I have alluded to. All but one of them had occurred since the collapse of the Michaux expedition, and that that one had occurred was not known until after the Michaux expedition collapsed. Captain Robert Gray took his ship, the *Columbia,* into the river thereupon named for her in 1792. He thus gave the United States a claim based on discovery to an undetermined fraction of Oregon. The claim was so formidable that till the settlement of the Oregon question in 1846 Great Britain was forced to affirm that Gray had not actually entered the river but had only anchored in a bay below its mouth. It was a claim which, if sustained, would give the United States title not merely to the mouth of the Columbia River but to its entire drainage basin. (Note parenthetically that this is more than in the end became American.) Though the geography was known only along the seacoast, there were conflicting claims to much of this region, perhaps to all of it. Who knew how much legal claim Great Britain had acquired by the Nootka Convention? Who knew how much Spain had forfeited? Who knew whether Russia had a valid claim to any part of the area, or if it had, how valid and to how large a part?

Following the *Columbia's* two voyages, the second of which was the one that took her to her discovery, the great age of American maritime commerce opened. Specifically, there developed the China Trade and that portion of it which was

based on the sea-otter trade of the northwest coast. Only the latter concerns us now. By the time Jefferson was inaugurated, the northwest trade had pretty thoroughly come into the hands of American traders and they were proceeding to monopolize it.

Throughout the 1790's the Canadian fur trade had been pushing overland farther west and north, vigorously led by the trust-like North West Company. In the year after Gray's entrance of the Columbia River, 1793, a principal figure in that trade had fulfilled one of its most important ambitions. Alexander Mackenzie, a partner of the North West Company, had performed his memorable feat of crossing Canada to the Pacific, thus making the first transcontinental passage north of Mexico. His crossing did not achieve its primary objective, which was also a primary objective of the Lewis and Clark expedition. He did not, that is, discover a commercially usable water route across the far Western wilderness. Nevertheless, his crossing had absolute importance.

Mackenzie understood the geopolitical necessities of North America precisely as Jefferson understood them. He was in actual fact, though the phrasing is of a later time, an agent of British trade imperialism. After making his great crossing, he proceeded to work out a platform of trade and politics which, I repeat, had a decisive effect on Jefferson's intentions.

Mackenzie held that the Canadian fur trade must secure a base on the northwest coast, so that it could obtain the economies of deep-water bulk transport. He held that it must have a canoe route from the coastal base to the great inland fields of its operation in the West and North. After Gray's discovery he believed that the Columbia River would provide that route. So he held that the Columbia and its basin must be, as he declared they in fact were, British possessions and that they must be defended by military establishments at Nootka and the mouth of the Columbia. He held that, if assisted by measures which Parliament must provide, possession of the Columbia would not only preserve the Canadian trust's monopoly of the fur trade of the western wilderness, but would recapture from the Americans the former British monopoly of the sea-otter trade of the northwest coast. Finally, he held that Great Britain was entitled to, and must move to secure, exclusive possession of the canoe route west from Grand Portage, and to a canoe route connecting Lake Superior with the Mississippi. This last thesis looked to British possession of a portion of American territory. It has additional interest for us in that, as Mackenzie said, it was associated with ambiguities relating to our northern boundary.

Mackenzie expressed these theses in his book, *Voyages from Montreal,* which was published in 1801, and in other writing. They were, of course, familiar before the publication of the book to Jefferson as an expansionist, a geopolitician, an Anglophobe, Minister to France, Secretary of State, and President. But the book became a focus of his thinking and Lewis and Clark took a copy of it west with them. Before and after it was published, Mackenzie did his utmost to procure action on his program by private enterprise, by Parliament, or by joint effort of both. It seems likely that the program would have been carried out wholly or in part before the Lewis and Clark expedition, except for the absorption of the government and of private finance in the Napoleonic wars.

Quite apart from that likelihood, however, there are facts. In 1800, the year of Jefferson's inauguration, the North West Company partners voted to establish west of the Rocky Mountains a post which would serve as a base from which such moves as Mackenzie proposed could be made. In the same year they sent pioneers over the mountains to locate a site for such a base. Some students believe, though in my judgment without convincing evidence, that two North West partners crossed the mountains to the selected site in the following year, 1801. At any rate preliminary moves to enter the area of contention had been made nearly three years before Jefferson's message to Congress proposing the Lewis and Clark expedition. In 1804, the year in which Lewis and Clark ascended the Missouri to Fort Mandan, a reorganization brought the North West Company under the direction of partners who supported Mackenzie's program. Almost at once, during the winter at Fort Mandan, a field-leader of that Company asked to accompany Lewis and Clark to the Pacific. The following year, 1805, the Company sent this same factor on a pioneering trip to open the fur trade in the American Rockies—that is in the American, not the Canadian, West—that is, again, on the way to Oregon. He was heading toward the upper Yellowstone River area while Lewis and Clark were reaching the Great Falls of the Missouri.

It is now clear why I have said that our primary emphasis should be on Oregon and not, as it has been traditionally, on Louisiana. Jefferson told Congress that the expedition was to establish an overland connection with the trade of the north-

west coast. He also intimated to Congress what he said explicitly and at length to Lewis, that it was to provide for that trade an inland water route, the advantages of which were obvious. Very likely, in fact almost certainly, such a route would make transport more rapid and, therefore, cheaper than it was by the route round Cape Horn. Quite certainly in a war-torn world it would be safer, for it would not be vulnerable to the navies and privateers of foreign powers. In a peace-time world, too, it would be beyond supervision by the British Navy. Jefferson did not say to Congress that an exploration of Oregon would strengthen the claim that discovery had given us, but in fact it did strengthen it and I do not see how we can suppose that this purpose was not in his mind. Moreover, the expedition acted to buttress the claim by means more aggressive and potentially more conclusive than exploration. I do not see how we can suppose that the representatives of the President of the United States, having crossed foreign territory and now present in disputed territory, would have taken action so purposive except on order.

This point must be made explicitly. I remind you that Jefferson's message to Congress dealt at length with challenging the Canadian fur trade in the West, and with providing a cheaper and more expeditious route for the transport of its furs than the Canadian canoe route, with its almost innumerable lakes and portages and its ice-bound rivers. I remind you too that Jefferson was on notification from Mackenzie and manifestly from the last ten years of North West Company action that Oregon and the northwest coast were in contention—that the Canadian trust intended to bind them to British sovereignty.

Oregon was west of the Continental Divide. At the time when preparations for the expedition were being made, the Divide was the western boundary of Louisiana, a French possession. By the time the expedition started, the Divide was the western boundary of the United States. When the expedition crossed the Divide, it entered the disputed territory of Oregon, to which the United States had the claim of discovery and was now establishing the claim of exploration. As soon as it did so, it came into contact with two transmontane Indian tribes, the Shoshones or Snakes and the Nez Percés. To both tribes Lewis made detailed proposals which looked forward to securing their trade for the United States. He told them that the Americans would establish trading posts east of the Divide but on their customary trade and hunting routes. In addition, the American government would protect both tribes, when they came to trade at these posts, from the marauding Blackfeet, whose menace, vaguely rumored when he left St. Louis, had been clarified by what he learned during the winter at Fort Mandan. So far this is merely a step in taking the trade of these transmontane tribes away from the North West Company, in accord with Jefferson's declared purpose in his message to Congress. But Lewis went on. As soon as possible, he promised the tribes, the United States would establish trading posts much more convenient for them, in their own country, west of the Divide. That is, in Oregon. That is, in the country to which the United States and Great Britain had conflicting claims, the country that was an object of contention between them.

It is unlikely, in fact it would seem impossible, that the representative of the President would make promises of such importance, and of such momentous implications, unless he had been directed to make them. The President's instructions to his representative begin with these sentences: "Your situation as Secretary to the President of the United States has made you acquainted with the objects of my confidential message of Jan. 18, 1803, to the legislature. You have seen the act they passed, which, tho' expressed in general terms, was meant to sanction those objects, and you are appointed to carry them into execution." I conclude that we have here additional evidence that Jefferson intended to secure Oregon to American sovereignty by promoting trade in it. Discovery, exploration, trade-occupation—that should do the job. I add that Lewis's report to the President from St. Louis on his return sketches out methodical plans for establishing trade west of the Divide, and it was written not only in the light of what the expedition had learned but in the light of the President's purposes. I find a curious urgency in these plans—an urgency so great that Lewis disregards the principal geographical lesson the expedition had learned. It had learned that a long and difficult land traverse must be made between Missouri and Columbia waters. This established forever that there was no inland water route from St. Louis to the Pacific. The great hope was proved unjustified and the very plans Lewis was sketching out were unrealistic, but he nevertheless made them.

I believe that we have here one of the two reciprocal reasons why Jefferson's message to Congress was a secret one and why the Act of Con-

gress authorizing the expedition was, as Jefferson reminded Lewis, "expressed in general terms." There could be no thought of keeping the expedition itself secret. In fact, it was immediately accredited to the governments of Great Britain, Spain, and France. But in his message Jefferson stated at considerable length the possibility of breaking the North West Company's monopoly of furs, and in turn of monopolizing its transport. The message was secret, I judge, because the implications would be as obvious to the North West Company and the British government as they were to the American Congress. Surely one of the obvious implications was the establishment of American trade in Oregon, which is what Lewis promised the tribes.

Here I must mention a paradox, the first part of which seems to weaken the point I have just insisted on. In his instructions, Jefferson directed Lewis to find out as much as he could about rivers flowing southward from the height of land that must separate the Missouri watershed from the unknown drainages that must reach Spanish New Mexico. He went on to say, "The Northern waters of the Missouri are less to be enquired after, because they have been ascertained to a considerable degree, and are still in course of ascertainment by English traders & travellers." Thus the instructions show no particular urgency about the very streams by which the idea Jefferson had expressed to Congress must be implemented.

In the actual outcome, however, not much was learned about those southern waters, which are the one geographical feature on Clark's maps that is conspicuously misconceived. The journals and memoranda of the expedition say very little about them. If the captains inquired exhaustively about them, the record does not show it, whereas the "northern waters of the Missouri," which the instructions say need be less inquired after, were in fact the object of the most constant inquiry and speculation. This was true while the expedition was wintering at Fort Mandan and while it was traveling from Fort Mandan to the Great Falls.

During the winter of 1804–1805 the captains amassed a remarkable amount of accurate information about the country they were to traverse during the spring and summer. They got most of it from the Hidatsa or Minnetarees. But they tirelessly questioned the Mandans too and all British traders who were resident with both tribes or who visited them from the posts on the Assiniboine River. Then when they resumed their journey, they investigated and speculated about every stream that entered the Missouri from the north, including the most trivial ones.

There is no doubt what they were looking for —they repeatedly say what it was. They hoped to find some stream capable of being navigated by canoes that could connect the Missouri with the routes of the Canadian fur trade. They wanted a stream that would enable American traders to intercept the North West Company's transport somewhere west of Lake Winnipeg. Repeatedly they specify: they are looking for a navigable stream that will provide connection with the Assiniboine River, the Saskatchewan River, or even, and this is most surprising, the Athabaska River. That is, they hoped to find a direct canoe route from American territory to the heart of the Canadian fur country.

While they analyzed what they heard and speculated about the possibilities, every tributary that entered the Missouri from the north might be the solution to their problem. During the winter they thought they had heard about the most feasible one, a stream which, doubtless translating a Minnetaree designation, they called the White Earth River. It was not the stream which bears that name today, and which is trivial enough. It was an even smaller creek which during most of the year will not float even a toy boat. When they had gone beyond the locality where, if anywhere, it must be, they continued deeply concerned to find some other stream that would serve the same purpose.

Here we must note another consideration. Not only must this sought-after stream provide access to the Canadian canoe route, it must also originate north of the forty-ninth parallel. While the captains were investigating the lower reach of every tributary from the north, and climbing bluffs to see how much of its upper course they could make out, they invariably insisted on the desirability of its extending north of 49°. It was a fixed requirement for their purpose. It was the reason why on the return journey Lewis split his party and made a reconnaissance of the Marias River, as during the preceding winter they had determined one or the other must. By that time the Marias was the only remaining hope, the only possible answer to the exigent question. He made the reconnaissance to determine whether it did in fact come down from north of 49°. His disappointment when he determined that it did not leaps at you from the page.

The reason for this urgent concern is not only implicit, it is also explicit. If a river whose source was north of 49° did in fact empty into the Missouri, then the Missouri watershed extended north of that parallel. Jefferson held that the entire Missouri watershed, since it was part of the Mississippi watershed, was included in Louisiana. The northern boundary of the United States would have to bend northward to include whatever waters might flow into the Missouri.

All this was part of the opportunity which Jefferson pointed out to Congress. It was the purpose of the expedition to discover not only an inland water route to the northwest coast but also one that would connect with the transport of the North West Company in the interior. Down such a route, he told Congress, it would be possible to divert the Canadian fur trade to American waters, to the Missouri, to the Mississippi or the Great Lakes, to the Ohio or some other American river, and so to American terminal ports. It was expected to be incomparably faster and cheaper than the Canadian route, for it would obviate the scores of portages, and Jefferson believed that it might be free of ice during the winter, or that at worst it would be icebound for only a short season.

When the expedition got to where it could investigate this opportunity, the forty-ninth parallel, or rather as Jefferson believed the northward bend that was to be substituted for it, had become the northern boundary of the United States. But it was not the northern boundary of the United States when Jefferson addressed Congress and during the long period of analysis and preparation that had preceded his proposal. It was the boundary of Louisiana, a Spanish possession that was becoming a French possession. It was a foreign boundary, the boundary of a foreign empire.

My opening statement about a change in the emphasis of our thinking about the Lewis and Clark expedition had two parts. The expedition was dispatched to reach Oregon, territory to which the United States possessed a claim and in which was localized the sea-otter trade that was a principal source of our external wealth. It was directed to discover a route which would permit that commerce to travel overland to the Atlantic seaboard, probably in shorter time and at less expense, and certainly protected from oceanic storms, shipwreck, piracy, privateering, and naval attack. This was an important objective. But to the extent that it was important, it suggests something else, and this is my second point. The more important it was, the more insistently it implies another conclusion.

The route which the expedition was to discover was to connect Oregon and the northwest trade with the United States, which then ended at the Mississippi. It was to connect them by crossing Louisiana, which was then foreign territory. But surely so vital a route, so earnestly desired and intended to serve so important a national purpose, surely there was no assumption that the territory it was to cross would long remain foreign. If it were to remain foreign, then it would be even more directly exposed to the hazards of piracy, blockade, attack, and capture than the oceanic route. And this was all the more true in that its foreign proprietor was the France of Napoleon, whose trade policy would deny all commerce that was not French access to French possessions.

There remains one minute but significant item, and it is pleasant to record that it occurs in a manuscript owned by this Society and given to it by the author, who was Jefferson. When Congress adjourned in the fall of 1803 and Jefferson returned to his library at Monticello, he took occasion to examine and review everything that bore on the extent of Louisiana, its boundaries, and the history of the various claims to it and of the treaties relating to them. As he wrote to the Society, he had collected in his library everything bearing on the subject that could be collected. At the end of his study he wrote a long memorandum which he called "An Examination into the Boundaries of Louisiana," copies of which he sent to the American ministers to France and Spain. The original he gave in 1817 to the American Philosophical Society. The "Examination" is dated September 7, 1803, but a "Postscript" is added to it under the date January 15, 1804. The Postscript is called "The Northern Boundary of Louisiana Coterminous with the Possessions of England."

At the end of this postscript Jefferson rejects the claim advanced by Mackenzie, the claim that Great Britain is entitled to a connection between Lake Superior and the Mississippi River. That problem, he says, was settled by the Treaty of Utrecht, and the boundary of the United States, that is of Louisiana, is the forty-ninth parallel westward to the point where it meets "the limits of the Spanish province next adjacent." (Remember that, though Jefferson had dispatched the Lewis and Clark expedition, its results were not yet in. If there is any Spanish province "next adjacent" to Louisiana at 49°, it is the area soon

to be called Oregon, to which the United States has a claim, to part of which Spain may or may not have a claim, to which Great Britain is asserting a claim.) And Jefferson makes a provisional exception, to allow for the possibility I have described, the possibility that Lewis and Clark so persistently investigated. "It would be desirable," he says, "to agree further that, if the parallel shall, in any part, intersect any waters of the Missouri, then the dividing line shall pass round all those waters to the North until it shall again fall into the same parallel, or meet the limits of the Spanish province next adjacent."

The sentence I have quoted is the last but one in the postscript. And now mark the last sentence. It reads, "Or unapprised that Spain has any right as far North as that, & Westward of Louisiana, it may be as well to leave the extent of the boundary of 49° indefinite, as was done on the former occasion."

The sentence falls into place as precisely as a tenon fits its mortise. Jefferson is saying that there is a possibility that the United States may be able to assert still another claim to the vast, vague region which his expedition will reach before the end of the year. That possibility may have been created by our purchase of Louisiana; it may be part of what we have bought. Note that he presents it not as a claim but as the possibility of a claim that may be asserted because we do not know the extent of a Spanish claim. Where does the northern boundary reach the western boundary? Where is the western boundary of the United States? Where in the west does Louisiana end? This is uncertain and it may be wise to preserve the uncertainty for the present. In short, we may have a claim to more of Oregon than we would get by extending the forty-ninth parallel across it as a northern boundary. But more than that, quite a bit more. Perhaps there is no next adjacent Spanish province so far north. If there is not, perhaps we can maintain that the United States already extends beyond the Continental Divide. Perhaps we can maintain that it extends all the way to the Pacific.

It is the American geopolitician who writes, "it may be well to leave the [westward] extent of the boundary of 49° indefinite." One relishes the irony, for the master of diplomacy, Talleyrand, had come to the same conclusion when the details of the Louisiana Purchase were being worked out. He believed in the wisdom of having something to negotiate about. Barbé-Marbois, who was conducting the negotiations with Monroe and Livingston, was disturbed by the uncertainty regarding the extent of the area first transferred by France to Spain and then by Spain to France, and now about to be transferred to the United States. When he said so, Talleyrand replied "that if the obscurity did not already exist, it would perhaps be good policy to put it there." So Jefferson: let us leave the westward extent of the northern boundary indefinite.

The inference mentioned in my title is now complete. The proposition I present to you is this: that in the long years of this thinking about an expedition to explore Louisiana, Jefferson had come to regard it as a means of hastening two processes. That he thought of it as a means of hastening the expansion of the United States to the Pacific, and as a means of hastening American acquisition of Louisiana. That he thought of it as a means of accelerating a process whose eventual outcome he regarded as assured. That, whatever else the expedition was besides, it was a deliberate act of expansionism. That, whatever else it was besides, it was a move in foreign policy.

This is not to suggest that dispatching the expedition had any bearing on the actual purchase of Louisiana, which occurred so dramatically after it had been authorized, while preparations were being concluded and before it started west. The antecedents of the expedition go back too far. But we must also say that, surprised and even stunned as Jefferson was by Napoleon's unforeseen proposal and its unauthorized acceptance by Monroe and Livingston, it can have seemed to him only the acquisition, prematurely and in one step, of territory which he had fully expected to come gradually into American possession. He said exactly that, and he must be accepted as speaking truthfully. We must remember that, from the peace treaty which followed the Revolution on, every foreign nation, and especially Great Britain, Spain, and France, had regarded American expansion into Louisiana as inevitable unless it should be prevented by force. If into Louisiana, then across Louisiana. And, as the diplomatic corps said repeatedly, if across Louisiana, then to New Mexico and to the Pacific.

We must remember too that Rufus King, our minister in London, and Livingston in Paris had made various suggestions and proposals to purchase large parts of Louisiana, or alternatively all of it. That Gallatin, the Secretary of the Treasury, favored buying all of Louisiana. That Jefferson regarded immediate seizure of Louisiana by the United States as a necessity if the world war

should involve the United States. That many Americans shared these convictions.

But most of all we must remember the basic fact repeatedly reported to their government by Spanish officials in New Orleans and St. Louis during the preceding few years, and reported by French officials as soon as they got to New Orleans. I refer to the fact that the westward-moving occupation of the wild lands by the American people had arrived in force at the western boundary of the United States, a boundary which could be crossed by dugout, and had moved on into Louisiana, thinly but in numbers visibly increasing. The bearing of this fact was clear to every diplomat in Washington, to every foreign office, and to all European students of world trends. Surely it was understood by the most brilliant American geographer, a lifelong expansionist, a master of geopolitics, a former Secretary of State, who was President during a period of world war.

This proposition is not documented. Rather, to speak precisely only parts of it are documented. But there is abundant supporting documentation in the Lewis and Clark expedition, and this seems to me the key. It cannot be left out of account, but I submit that it has been pretty largely left out of account. We need more search for documentation than we have so far had.

If the change in emphasis which my proposition indicates is so important as I assert, can I account for the neglect of historians in general to adopt it? I believe I can, at least in part.

To begin with, there is the Louisiana Purchase itself. Massive and momentous, it realigned world forces and generated historical energies that have been in operation ever since. Because it was so momentous, there has been a tendency to focus inquiry on what happened as consequences and to neglect what had already happened that might be related to Lewis and Clark. To this is added the magisterial authority and prestige of Henry Adams. I submit that his analysis of the Purchase does not stand up under examination, but has largely gone unexamined. Briefly, Adams is under compulsion to represent Jefferson's brilliant appraisal of world forces and his brilliant conduct of foreign and domestic policies bearing on Louisiana—to represent Jefferson's ideas and actions as ignorant, misconceived or deluded, floundering, improvised, and successful only by the providential workings of chance. So he leaves out of account the highly important, and for Lewis and Clark decisive, elements of the total situation which I have mentioned and which Jefferson did take into account.

Again, there has been a tendency to study the Lewis and Clark expedition in the context of Spanish-American relations, or of British-American relations, or of French-American relations—that is to study it compartmentally, as a reciprocal action—and not in the actual four-part context, that is as a resultant. There has also been a semantic reluctance so great that it might be called a taboo. Jefferson, we have been told, was an "expansionist" but he was not an "imperialist." The words are arbitrary and elastic but the implication may be stated thus: Jefferson was willing for Louisiana and Oregon to come eventually under American sovereignty by evolution of the historical process, but he would not act to bring them under American sovereignty. Therefore, indications that he did act must have other explanations.

Finally, I believe, our idea of the historical process itself has worked against the proposition I have submitted to you. We think of the immensely complex historical process as having such enormous inertia that it is not subject to redirection by individual acts. However purposive an act, it cannot influence the process very much, and so it must be thought of as either at random or a consequence, not as a cause. One by one holes will be punched in the cards, but always as consequences—as consequences of events and the process itself, not of acts by persons. So in due time the current will flow through the holes as punched and form circuits and there will be an expedition to the mouth of the Columbia. The process of history dispatched the expedition of Lewis and Clark; Jefferson was only a hole in the card through which the current flowed to form the circuit.

I do not care to reject one theory of history and support another one in a final paragraph. I do say that it was Jefferson who punched the holes in the card. There are a lot of them. They form a design and they produce a design. I hope I have made clear that it was a larger and more complex design than we have tended to believe. I cannot account for it as chance but only as purpose.

THE SECULAR INCREASE IN THE LENGTH OF THE DAY

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(*Read April 21, 1955*)

In the year 1695 Edmond Halley, who later became the second Astronomer Royal, announced that the motion of the Moon was being accelerated. Halley had collected all the ancient observations of eclipses that he could find; comparing the positions of the Moon deduced from these observations with the positions in his day, he found that the mean motion of the Moon during the interval of some two thousand years was less than the mean motion derived from current observations. The longitudes of the places at which the eclipses had been observed were not known in Halley's day with sufficient accuracy for him to evaluate the acceleration. He remarked that,

> If any curious Traveller, or Merchant residing there, would please to observe with due care, the Phases of the Moon's eclipses at Bagdat, Aleppo and Alexandria, thereby to determine their Longitudes, they could not do the Science of Astronomy a greater service. For in and near these Places were made all the observations whereby the Middle Motions of the Sun and Moon are limited.

The theory of the motion of the Moon is of great complexity. The Moon is subject to the gravitational attraction of the Sun, the Earth, and the other planets, which move in orbits that are slightly elliptical and that are inclined at different angles to the ecliptic—the plane in which the Earth moves round the Sun. The orbit of the Moon around the Earth is also elliptical. The spheroidal figures of both the Earth and the Moon have to be taken into account. The attractions of these other bodies on the Moon, continually changing as their distances from the Moon change, are evaluated in lunar theory as the sum of a large number of periodic terms with many different periods. The true longitude of the Moon can be expressed as a mean longitude together with all these periodic terms, representing the perturbing action of the other bodies in the solar system. If observations of the Moon's longitude, separated by a sufficient interval of time, are compared the effect of the perturbations can be neglected as a first approximation, and the mean motion in longitude can be approximately evaluated without a knowledge of the perturbations.

The longitude of the Moon can be considered as increasing continually as the Moon revolves round the Earth. In one revolution it increases by 360°; in n revolutions by $n \times 360°$. It would be expected that the mean longitude could be expressed in the form

$$L = L_0 + L_1 T,$$

where L denotes the mean longitude at time T, L_0 is its value at the epoch from which the time is measured, and L_1 is the rate of increase in longitude with time. Halley found, however, that the mean longitude was being accelerated; it must consequently be represented by an expression of the form

$$L = L_0 + L_1 T + L_2 T^2,$$

where L_2 is a positive quantity.

The evaluation of the acceleration was first made by the Rev. Richard Dunthorne in 1749. He found from a discussion of observations of eclipses going back as far as one observed at Babylon in the year 721 B.C. that the coefficient L_2 had a value of about 10″, when the time T is expressed in centuries.

The effect of this term is readily seen. Going back in time for, say, twenty centuries, the third term in the expression for the mean longitude has the value 4,000″. As the Moon moves about half a second of arc in a second of time, the effect amounts, when expressed in time, to about 2¼ hours. When the early observations of eclipses were made, time keeping was pretty crude, but it will be realised that no great accuracy in the knowledge of the times of occurrence of the eclipses was required to enable an effect which puts the Moon more than two hours out of its expected position to be detected and estimated.

For more than a century after Dunthorne's determination of the acceleration many unsuccessful efforts were made to account for it. The search for a satisfactory explanation became one of the cardinal problems of astronomy, which at-

tracted the attention of many of the great geometers and mathematicians of the eighteenth century, including Euler, Lagrange, and Laplace.

In 1754 a remarkable essay was published by Emanuel Kant, the title of which (when translated into English) was "Whether the Earth in its revolution has experienced some change since the earliest times." In this essay Kant pointed out that the action of the Moon in raising tides on the oceans must have a secondary effect in a slight retardation of the rotation of the Earth. As the Earth rotates, the tidal bulges remain in a more or less fixed position in relation to the direction from the Earth to the Moon; relative to the Earth itself the tidal bulges are drawn round the Earth in a direction opposite to its rotation and the waters may be expected to exert a braking effect on the Earth. He supposed that tides raised on the Moon by the Earth had in a similar manner slowed down the rotation of the Moon until eventually it always turned the same face to the Earth, when the braking effect would cease.

If the rotation of the Earth is being slowed down in the way Kant suggested, there would be an apparent acceleration of the motion of the Moon. Let us imagine that the length of the day suddenly increases, so that today is longer than yesterday. The longitude of the Moon will obviously increase by a greater amount today than yesterday. If instead of a sudden increase in the length of the day there is a slow secular increase, then the rate of motion of the Moon in longitude will show a slow secular increase; in other words, the motion of the Moon will appear to be accelerated. The rotation of the Earth on its axis provides us with our standard unit of time, the day, which we assume to be constant. The observed acceleration of the motion of the Moon may consequently merely be an apparent effect arising from the gradual lengthening of our unit of time.

Kant's suggestion was considered by Laplace when he was seeking for an explanation of the acceleration of the Moon's motion; but he discarded it because, as he rightly pointed out, the motions of other bodies in the solar system should also show an acceleration if the rotation of the Earth were being slowed down, and such accelerations had not been observed.

In 1787 Laplace announced that he had found the explanation of the Moon's acceleration. The effect discussed by Laplace is somewhat involved and it is not necessary here to discuss it in detail. Laplace showed that the eccentricity of the orbit of the Earth round the Sun is decreasing continually, though extremely slowly, as a result of the gravitational attractions of the planets on the Earth. This gradual decrease of the eccentricity causes a gradual decrease in the mean action of the Sun upon the Moon which, Laplace showed, results in a slow increase in the Moon's mean motion. Laplace computed the magnitude of the acceleration of the Moon's mean longitude and his computed value was in excellent agreement with the best value provided at that time by observations.

So the question was apparently settled at last, the acceleration of the Moon's motion being accounted for by a gravitational action. There was no need to attribute it to a retardation of the Earth's rotation by tidal friction, and Kant's suggestion faded out of sight.

But the whole question was reopened again in 1853 when John Couch Adams, who as a young man had predicted the position of an unknown planet—now known as Neptune—which was responsible for the perturbations of Uranus, found that the calculations of Laplace were incomplete. Adams revised the calculation and found that the true secular acceleration of the Moon's motion arising from the gravitational effect considered by Laplace was not much more than half the observed value. Several other astronomers then repeated the computations but did not agree either with each other or with Adams in their results. For a time a furious controversy raged. Adams pointed out that the question was a purely mathematical one, the computation being effected by means of an algebraic process, the validity of each step of which admitted of being placed beyond all possible doubt. The value of the acceleration obtained by Adams was eventually agreed to be correct.

As it appeared that about one half of the observed acceleration could not be accounted for by gravitational theory, Kant's suggestion that the rotation of the Earth was being retarded by tidal friction was revived. In 1905 Cowell, at Greenwich, found that the mean motion of the Sun was also being accelerated and this result made the hypothesis of tidal retardation more plausible. The acceleration of the Sun's motion is appreciably smaller than that of the Moon, because the mean motion of the Sun in longitude is only about one-thirteenth of that of the Moon. The discovery of the acceleration of the Sun's mean motion had not been made earlier because it was more difficult

to detect than the acceleration of the Moon's mean motion. More recently accelerations of the mean motions of Venus and Mercury have also been confirmed. The observations of the Sun, Venus, and Mercury can be satisfactorily represented on the hypothesis that the accelerations of the mean motions of these three bodies are proportional to the mean motions themselves, as they should be if they are all produced by a retardation of the rotation of the Earth.

But for the Moon the position is otherwise. The accelerations of the mean motions of the Moon and the Sun, for instance, are not in the ratio of the mean motions of these two bodies. The reason is that where tidal action is concerned, the Earth and the Moon must be considered as a single system, whose angular momentum is conserved. The tidal bulges raised on the Earth by the Moon's attraction have an effect on the Moon: the two tidal bulges, being at slightly different distances from the Moon, exert gravitational pulls on the Moon which are not exactly equal. There is a small residual effect, which is such that it produces an acceleration of the motion of the Moon and, therefore, by Kepler's laws, causes the Moon to recede slowly from the Earth. Because we do not have a detailed knowledge of the forces that are acting, we cannot calculate the ratio of the accelerations of the Moon and of the Sun.

The secular retardation of the Earth's rotation by tidal friction appears qualitatively adequate to account for the accelerations of the mean motions of the Moon, the Sun, Mercury, and Venus. But when the problem is looked at quantitatively there is a difficulty. Several discussions of the tides in mid-ocean were made and it appeared that neither viscosity nor turbulence in the oceans can cause sufficient friction to account for the observed acceleration of the Moon's motion. The rate of increase in the length of the day needed to explain the residual secular acceleration of the Moon requires a calculable rate of dissipation of energy by tidal friction—a rate of about 2,000 million horse-power; the actual rate of dissipation of energy in the oceans is very much less than this, smaller by a factor of about a thousand. It seemed, then, that tidal friction was quantitatively not competent to provide an explanation.

It was not until 1920 that the way out of this difficulty was found. In that year it was pointed out by G. I. Taylor that, since the rate of dissipation of energy by tidal friction is proportional to the cube of the tidal current, it is only the regions where there are large tidal currents that need to be considered. The open oceans and all seas where the currents are very small contribute practically nothing to the total dissipation of energy. Large tidal currents are almost always to be found in small areas close to the shore, and the most favourable basins for tidal dissipation of energy are long bays and channels where the waters are comparatively shallow, provided they are situated in places where the general ocean tides tend to produce a large rise and fall of tide.

Taylor computed the rate of dissipation of energy in the Irish Sea and found that it accounted for about two per cent of the total dissipation required to account for the rate of retardation of the Earth's rotation necessary to explain the acceleration of the Moon's motion. The problem was then taken up by H. Jeffreys, who investigated the dissipation of energy in all the narrow and shallow seas of the globe. He found that by far the most important of them was the Bering Sea, in which sea alone the dissipation of energy proved to be about seventy per cent of the dissipation in all seas. Using the best data available, which are admittedly somewhat uncertain and for some areas incomplete, Jeffreys obtained a computed total rate of dissipation which was about eighty per cent of what is required to account for the whole of the unexplained secular acceleration of the Moon's motion. The agreement was, in fact, much better than might have been expected when the uncertainty of many of the data are borne in mind. The computed rate of dissipation was 1.1×10^{19} ergs/second.

But there is another effect which bears on this question of the retardation of the Earth's rotation and which, surprisingly, was completely overlooked by all investigators until attention was drawn to it a few years ago. The most regular variation in the height of the barometer is a large semi-diurnal variation; in low latitudes, where depressions are of infrequent occurrence and where this variation is greatest, it repeats regularly day after day. In other regions, where the barometric height varies considerably, the semi-diurnal variation can be disentangled by analysing data for a sufficient period to average out the irregular changes. The most noticeable feature of the semi-diurnal variation is that its phase is remarkably constant over the globe.

In 1882 Sir William Thomson (afterwards Lord Kelvin) suggested, in a paper published in the *Proceedings* of the Royal Society of Edin-

burgh, that the large amplitude of the semi-diurnal barometric variation and its constancy of phase could be the consequence of the close coincidence between the period of the Earth's rotation and the natural period of resonance of the atmosphere. It is now known from other considerations that these periods cannot differ by more than a few minutes.

The phase of the oceanic tides is such that the tidal maxima come in the first and third quadrants, and the attraction of the Moon on these tidal bulges has the effect of retarding the Earth's rotation, as we have seen. Kelvin remarked that the phase of the semi-diurnal barometric variation is such that the atmospheric tidal bulges occur in the second and fourth quadrants after midnight; the gravitational attraction of the Sun on the atmospheric tides consequently exerts an accelerating couple on the Earth, instead of a retarding one. Kelvin computed the rate of working of this atmospheric couple.

Holmberg has recently drawn attention to this long-overlooked paper. At first sight it appears somewhat anomalous that the atmospheric tidal couple can accelerate the Earth's rotation, as an increase in the mechanical energy of the system is required. Holmberg points out that this energy is extracted from the solar heat falling on the Earth by a heat-engine effect. He has made an estimate of the work done by the atmosphere in a given time, which is a measure of the net gain in mechanical energy. In order that work must be done the phase difference of the diurnal variations in atmospheric pressure and temperature must be positive. Observations are in general agreement with this, as the temperature maximum tends to occur in the afternoon and the maximum of the diurnal pressure component in the forenoon.

Using reasonable values for the diurnal variations of pressure and temperature, he finds that, if the whole atmosphere were working at the same rate, the amount of work done would be about forty times greater than the rate of working of the atmospheric couple. It is, of course, only the air near the surface and primarily in the equatorial belt that is working at anything like the estimated rate. There is no difficulty in concluding, however, that the mechanical energy involved is actually extracted from the solar heat. Using modern data for the world semi-diurnal pressure variation, which give

$$\Delta P = 1.25 \times 10^3 \sin^3 \theta \cos (2t + 64°) \text{ dyn/cm.}^2,$$

where θ denotes the colatitude and t the local time, Holmberg finds that the total atmospheric accelerating couple works at the rate of 2.7×10^{18} erg/sec. As the above expression for ΔP is based on a large number of observations at different places, this estimate should be accurate to a few per cent. It is about one-quarter of the rate of working of the oceanic retarding couple, as computed by Jeffreys, the value of which may be in error by as much as 50 per cent.

The reason why the atmospheric couple is comparable with the tidal couple, despite the great difference in densities of air and water, is that the atmospheric tide is greatly amplified by resonance.

Holmberg suggests that the Earth's rotation has been slowed down by tidal friction until it approached the natural period of vibration of the atmosphere. This approach was accompanied by a considerable amplification of the atmospheric tide. There may now be a statistical balance between the two effects, so that the Earth's rotation is kept constant.

What is now urgently needed is a more accurate computation of the oceanic tidal retarding couple. Possibly the data that will be obtained from the observations during the International Geophysical Year will permit of a revised computation. Until the oceanic tidal retarding couple is computed with greater precision we cannot decide whether the close agreement between the rate of the Earth's rotation and the natural period of resonance of the atmosphere is fortuitous or not.

The evidence now available suggests that at the present time the oceanic retarding couple is somewhat greater than the atmospheric accelerating couple. But changes in sea level, which may occur within times that are astronomically and geologically short, would have their greatest proportionate effect on the shallow seas, so that there may be an appreciable fluctuation in the magnitude of the ocean couple. The balance of evidence at the moment is that there has been some retardation in the rate of the Earth's rotation during historical times.

The astronomical evidence is not conclusive. A complicating factor is introduced by the fact that the Earth's rotation is subject to small erratic changes, which result in fluctuating divergencies between the observed and theoretical positions of the Moon, Sun, Mercury, and Venus. These fluctuations are similar in character for the four bodies and must consequently be attributable to changes

in the Earth's rotation. The cause of these changes is not known, but it is certain that they must lie deep within the Earth.

The difficulty in the analysis of the observational data is that information of the fluctuations is available only for the last two centuries or so. The secular retardation of the Earth's rotation has been inferred from the early eclipse observations in conjunction with the assumption that the mean of the fluctuations during the past two centuries is zero. Though we can adopt any zero we please, we have no means of estimating what the integrated effect of the irregular changes in the Earth's rotation amounted to at the times of the early eclipse observations. The effect might have been quite large.

We can in fact select any value we please (within reasonable limits) for the secular retardation of the Earth's rotation and attribute the residual divergencies between observation and theory to the effect of erratic changes in the rotation of the Earth. We can represent the observations by attributing the whole of the divergencies to these erratic changes, without introducing the hypothesis of a secular retardation of the rotation. The available astronomical evidence does not enable us to state definitely whether or not the Earth's rotation is at present being secularly retarded by tidal fraction. An accurate evaluation of the dissipation of energy in the shallow seas of the globe is essential for a decision between the alternatives to be possible.

PHOTOGRAPHIC STUDIES OF THE FEEDING OF NESTLING HOUSE WRENS

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(*Read April 22, 1955*)

MANY studies have been made of the feeding habits of birds, principally to demonstrate what useful creatures they are in the control of insects that are injurious to crops. Unfortunately, these valuable investigations have involved the drastic and somewhat messy method of killing large numbers of birds, dissecting them, and analyzing the contents of their stomachs. I suppose the needs of science can easily be shown to justify the use of techniques even as harsh as this, but it seemed to us that everyone would be happier—and particularly the birds themselves—if some less permanently injurious method could be devised for prying into their gastronomic private lives.

The use of the photographic process for this purpose is not a new idea. There is in fact a suggestion, together with some exploratory photographs, in the *Bulletin* of the Wilson Ornithological Club for December, 1914. We, therefore, claim no originality for the basic method discussed here and present only some refinements in technique and the results of a good many hours of patient observation.

One of us has for some years been photographing birds in flight and at their nest, using high-speed electronic flash lamps. Some pictures taken of an obliging pair of house wrens showed that it was not only possible but relatively easy to identify the food being carried to the young. It occurred to us, as it apparently has to others, that this technique might be useful in supplementing information on feeding habits already in the literature. The method, in theory at least, is applicable to any bird that does not predigest its food before passing it on to its young. We selected the house wren for this preliminary study, first, because its breeding sites were conveniently at hand, and second, because the frequency of its visitations permitted many data to be accumulated in a relatively short period of time.

The apparatus and technique used may be described briefly as follows: A camera producing negatives 2¼ inches square was fitted with a shutter synchronized for electronic flash and capable of being triggered through a solenoid mounted in the cable release opening. A flashlight and photoelectric cell were so placed that the beam of light crossed the axis of the hole in the wren's nesting box and was about 2½ inches in front of the opening. Through appropriate relays the solenoid on the camera shutter was energized whenever the light beam was broken.

A pushbutton and cord, which could be operated remotely, permitted energizing the circuit at the operator's choice; hence pictures could be restricted to the time when the wren *entered* its nesting box. The electronic flash lamps operated at 2,600 volts with a capacitance of 14 microfarads, giving a flash duration of about 50 microseconds, amply short to stop action completely. The camera was so placed that the picture area photographed was about 7 inches square, or a linear reduction of approxmiately 3 : 1 from object to negative. The resulting contact prints were quite good enough to permit fairly ready identification of the insect prey being carried to the young.

The apparatus could, of course, be elaborated to the point of making it fully automatic; saving much wear and tear on the observer. A moving-picture camera, for example, could be substituted for the still camera which would permit automatic picture-taking to the limit of the film content of the camera. We have not yet been able to devise a method for informing the camera whether the bird was coming or going; hence the automatic procedure would produce two pictures per visit, one on arrival and one on departure. Pictures in color would of course greatly facilitate identification of the insect, and, if moving-picture film were used, this would not add unduly to the expense of the experiment.

The technique is most easily adapted to birds nesting in cavities or which will adopt nesting boxes. This is simply because the well-defined entrance permits placing the photoelectric beam so that pictures are assured at each visit. With open nests such as are built by robins, sparrows, and thrushes, it is doubtful that the photoelectric beam can be relied upon to make the taking procedure automatic and we can, therefore, only suggest that the observer sit still, have patience, and trigger his camera by hand.

The experiments on nesting wrens were made in the summers of 1953 and 1954 and represent two separate family rearings. Some four hundred pictures were taken of which 90 per cent or more showed the insect prey in the beaks of the parents. This number, while significant from a statistical point of view, represents only a small fraction of the visits made.

Before discussing the identification of the insect prey, a few comments on frequency of visitation of the parent may be of interest. For these we use the data obtained during the single nesting period in June, 1954.

The nesting box in this instance was located in the lower end of a garden adjoining a fairly extensive deciduous woods. The first egg was laid on May 17 and additional eggs were laid on successive days until May 23, a total of seven. The young hatched on June 6. Feeding habits and frequency of visits were observed on June 12, 13, 17, and 19, and the young left the nest during the morning of June 21. It is difficult to distinguish male from female but we suspect strongly that during the period of observation only the female attended the young, the male somewhat ungallantly pursuing his own devices elsewhere.

Table 1 presents data on frequency of visitation. The column at the left of the table gives the interval between visits. The percentages under the dates of observation represent the percentage of the observed visits occurring at the designated interval in the left-hand column. For example, on June 19, 7 per cent of the observed visits were at intervals less than one minute, 45 per cent were at intervals between one-half and one and a half minutes, and so forth.

It seems reasonable to conclude that frequency of visitation is related simply to the needs of the young and not necessarily to the abundance of food available to the mother. Note, for example, that on June 12 and 13, when the young were about six days old, the average interval between visits was 3.4 minutes. On June 17 and 19, when the young were more mature and presumably in greater need of sustenance, the period between visits averaged about 2 minutes. It would seem, therefore, that the parent has no difficulty in finding food at whatever rate called for by the state of growth of the young. This hypothesis is borne out by data in the literature on the period required for the young to reach flying age, which for the house wren is relatively constant at twelve to fifteen days.

TABLE 1

FREQUENCY OF VISITS

Interval	Per cent of visits		
	6/12-6/13	6/17	6/19
0	—	1	7
1	22	51	45
2	31	22	20
3	11	14	13
4	11	5	6
5	8	4	0
6	7	2	2
7	3		2
8	2		1
9	1		1
10	1		1
11	1		1
17	1		
18	1		
Number of visits observed	118	98	97
Average interval between visits (min.)	3.4	1.9	2.2

We are not sure what factor brought about the few long intervals between visits, viz., 8 to 18 minutes. In one case, however, on June 19, we are quite certain that it was the advent of the male who apparently concluded that it was time for his bride to divide her attentions at least to some small extent between himself and her young. As nearly as we could observe, they went off on a ten-minute romp together after which the female returned to tend her offspring. During the romp the young became more and more vociferous and had the observers been able they would have been strongly tempted to act *in loco parentis*.

The photographs reproduced here indicate the general character of the pictures obtained and demonstrate the relative ease with which the prey can be identified. We confess that the pictures have been selected to present our best results but it can fairly be said that they are not far from

TABLE 2

SUMMARY OF FOOD ITEMS BROUGHT TO WREN NESTLINGS

	% of each food item					Grand total*
	June 13, 1953	June 14, 1953	June 12–13, 1954	June 17, 1954	June 19, 1954	
Adult Lepidoptera (Moths)	82	17	46	21	56	43.7
Phalangids (Daddy-longlegs)	4	10	11	54	19	18.9
Spiders	10	40	12	11	7	14.6
Orthoptera (Crickets, Grasshoppers)	2	13	12	7	7	9.2
Caterpillars	—	8	7	3	5	5.4
Diptera (Flies)	2	6	6	2	2	4.0
Coleoptera (Beetles)		5	2		1	1.5
Hymenoptera (Wasp, Parasite)			1	1		0.5
Coccidae (Scale insects)			2			0.5
Heteroptera (True bugs)		2			1	0.5
Blattaria (Roaches)				1	2	0.8
Acarid (Tick)			1			0.2
Chrysopid (Lace-wing fly)						0.2
Total	100	100	100	100	100	100
Number of Items	51	63	93	75	98	403*

* Including 23 miscellaneous photographs taken at other times.

average and even the worst of them permitted identification after some study.

Of the more than four hundred prints resulting from these experiments, about 10 per cent of the exposures failed to catch the birds in position before the nest, or showed them with heads hidden or with beaks empty of visible prey. The remainder showed clearly that the supplied food was solely of animal nature (Arthropods), with insects predominating in variety and number.

The total number of food-items shown was somewhat greater than the number of photographs for in a number of instances (not always fully determinable) a returning bird carried two insects in its beak. The second capture was sometimes identical in kind with the first—for example, two moths or two spiders—but was sometimes wholly different, such as moth and Phalangid, moth and a fly, or fly and caterpillar.

In general, the prey was not dismembered, but was grasped firmly in the beak of the bird without extensive mutilation. Many of the food-items could be given general classification upon examination with the naked eye; on all, a 7 × triple aplanat was employed, and upon some a low-power binocular under various lightings was employed for greater certainty of identification. In slightly more than thirty instances, however, though the Arthropod nature of the food was obvious, the condition or partly-hidden position prevented its further classification.

Table 2 lists 403 food-items, possible of such classification, arranged by dates of observation and the percentage representation of the various forms.

Even a casual examination of this table reveals wide variation, from day to day, in the character of the food-items; for three of the five periods, moths greatly predominated in number; on two other days, spiders and daddy longlegs occupied the top position. These differences cannot be correlated with weather conditions, with the hours of capture, or with the age-requirements of the young birds. While sometimes relative abundance may have been a factor, it would seem that a temporarily formed habit of looking for certain groups, or in the search of certain areas and habitats, had influenced the proportionate representation of these various groups among those captured. Examination of the detailed record by group classification confirms that point of view.

The published papers of several authors on the food of adult wrens, as determined by the examination of their stomach-contents, have indicated that grasshoppers and beetles often make up half of the food taken; or sometimes record that bugs, grasshoppers and their allies, caterpillars, and beetles (in the order named) have been detected as its chief constituents. Similarly, several papers on the food items carried by wrens to their

FIG. 1. Caterpillar.

young indicate a divergence in character from the preferred diet of adult birds, in favor of softer fare such as caterpillars and mayflies, for their nestlings.

The present tabulation, based on the later nest-life of the house wren, shows that adult Lepidoptera sometimes constitute nearly half of the food-items brought by the parent birds.

Among the 176 lepidopterous adults identified, general characters of family or genus could usually be detected, and sometimes even specific identity was determined. Conspicuous by their absence were the Arctiidae, Notodontidae, Liparidae, Lasiocampidae, though some of these must have been available for capture. Smaller moths ("Microlepidoptera") were scarcely ever recognized, a single Pyralid being the exception. Geometrids were represented by less than half a dozen examples. When decisive characters could be distinguished, practically all of the remaining adult Lepidoptera could be assigned to various Noctuid genera: insects of moderate size, smooth abdominal and wing vestiture, slender setaceous antennae. Parents of several species of injurious cutworms were frequently represented. On one day *Leucania unipuncta* (parent of the army worm) was brought to the nest in such numbers and at such short intervals that a seasonal mass-emergence of this species was inferred; next in order of abundance was *Lacinipolia renigera*, followed closely in numbers by *Agrotis c-nigrum*—all of these having recognized pest-importance. The number and quick succession in which such Noctuid moths were brought to the nest were difficult to explain. In an extreme instance, nine of these moths were brought within a period of only twelve minutes, and it would tax a human entomologist to find and capture that many in so short a time.

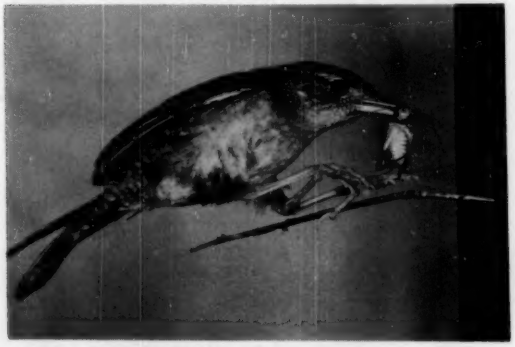

FIG. 2. "Camel Cricket." Genus *Ceuthophilus*. Probably *C. lapidicola*, female.

FIG. 3. Grasshopper, immature. Probably subfamily Acridinae.

Among the Lepidoptera, one unexpected capture was a butterfly, for in our climate butterflies are rarely observed to be preyed upon by birds. This capture could not be identified specifically, for its wings were badly crumpled, thus suggesting that it may have been taken, while soft and helpless, upon its emergence from the pupa.

Caterpillars, only 22 in number, were strangely scarce in representation.

Phalangids (daddy longlegs) and spiders, in the order named (respectively 76 and 59), came next to the Lepidoptera in frequency of capture. The spindly-legged Phalangids would seem to offer little of nutritive value, but perhaps their habit of mass-assemblage contributed to ease of capture and explains their popularity with the parent wrens.

Spiders, only slightly fewer in number, exhibited a wide range of species. Obviously they came from various habitats, for they included large ground-inhabiting Lycosids sometimes carrying their egg-sacs; crab spiders, which frequent flowers; jumping spiders (Attidae); orb-weavers; and in one instance a black spider whose proportions and body-texture definitely suggested the notorious "black widow."

Grasshoppers and crickets (Orthoptera), fourth in numerical position among the recognized captures, numbered 37 insects representing only a few species. These included the bulkiest of all the insects brought to the nest (a nymphal Acridid); a grouse locust (Tetrigidae); and more numer-

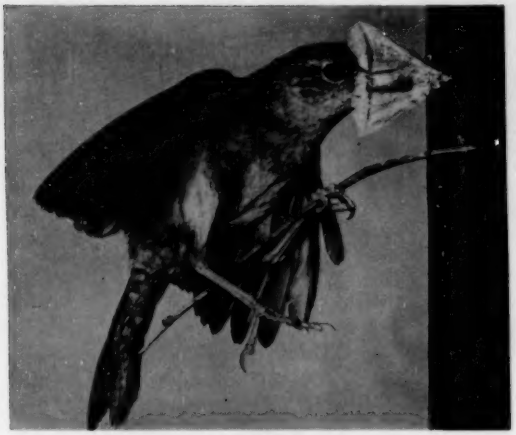

FIG. 4. Noctuid Moth. Probably genus *Mocis*.

ously, crickets of small or moderate size; all these were ground-inhabiting insects.

The list of captures is completed with the record of 16 flies of diverse genera; 6 beetles; 3 small roaches; one wasp and one parasite representing the Hymenoptera; 2 bugs, 2 scale insects; one lacewing fly and one tick. These progressively decreasing numbers seem to indicate that they represent incidental and opportunist captures, rather than the result of systematic search.

It is realized that this record is incomplete because it extends over only a small portion of the nest life, and also because it is the record of food available and chosen from the feeding area surrounding a single nest-site. With different types of insect-habitat available, the proportionate choice of prey would surely have been different. It does, however, demonstrate that all of the provided food

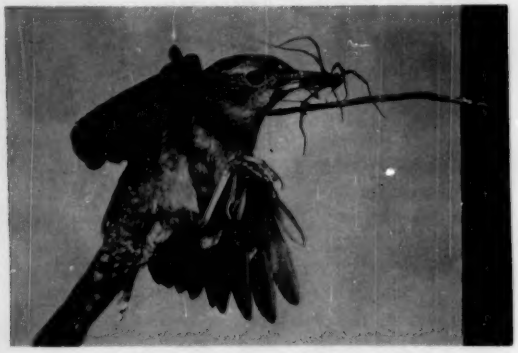

FIG. 5. Daddy Longlegs. Phalangid.

was of animal origin, and that in both numbers and bulk, phytophagous species predominated, to that extent establishing the economic status of these birds.

Most of the investigations of the economic status of birds in their relationship to man have been made by examining the stomach-contents of adults. Our own investigations, on the other hand, deal with the food brought to nestlings. It is interesting to speculate which method (if indeed a choice must be made) yields the more significant result. The house wren in common with most small birds raises two broods a year, which involves carrying as many as twelve offspring from birth to maturity. We suspect that the quantity of food required to accomplish this result may be substantially greater than that required to sustain two adults for a year. If this is so, the economic value of a given small bird might well be quite precisely established by recording the food brought to its nestlings.

CONTROVERSIAL FACETS OF OLD-AGE SECURITY*

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(*Read April 22, 1955*)

THE governmental program for providing financial security for aged persons in this country could be described in detail and adequately discussed only in an amount of space that is not available to us today. Therefore, in presenting this paper it is assumed that the reader has a broad knowledge of our old-age security system, thus making it possible to concentrate upon certain interesting facets of the subject about which differences of opinion and attitude have developed. These facets relate to problems about which we shall be hearing as Congress from time to time considers revisions of the Social Security Act. They will be presented under the following ten headings: Basic Philosophy of Social Security; Levels and Types of Benefits; Economic Burden and Estimates of Cost; The Work Clause; Coverage; The Retired Unprotected Aged; The Role of Old-Age Assistance; Taxes and Reserves; Nature of the Reserves; Double Taxation.

BASIC PHILOSOPHY OF SOCIAL SECURITY

Despite the fact that the original Social Security Act of 1935 and its subsequent major expansion became law by overwhelming majorities in Congress, many people still dislike and fear the entry of the federal government into this kind of activity for the benefit of nearly all the individuals in the country. They see in it a serious threat to the development of a strong, self-reliant citizenry without which the United States cannot hold its own in this dangerous world. They see in it the creation of a system providing a powerful tool which a political party could use to entrench itself in power through attractive, lavish promises to the electorate. In that direction lies control of the Congress by the executive, and later the control of the courts, the joint creation of the executive and legislative branches of our Government. In this way the checks and balances built into our Constitution for the purpose of preventing totalitarian control by the executive could be destroyed and the door opened to dictatorship wielded say by a Huey Long type of president, elected in a time of economic recession.

Some of these dangers are potentially very real. We see tendencies in that direction in the liberalizations in the Social Security Act made by Congress shortly before the elections in 1950, 1952, and 1954. And it looks as though the stage was being set for 1956. The question is: what can and should we do about it? For one thing, the American people should be educated to understand the nature of their old-age security system and the dangers inherent in the liberalizations that can so easily be made under the present set-up with but little current inconvenience and cost, but having serious threats for the future. This will be brought out later.

I doubt that there is anyone who believes that it would be possible to persuade American voters to abandon the Social Security principle. The great depression of the 1930's violently changed many of their basic concepts. Millions, through no fault of their own, found themselves out of work and were eager to follow a political leader who promised to do something about it. That political leader was Franklin D. Roosevelt, who proposed a Social Security program based in many respects upon what had been developed in the industrial countries of Europe. When it came before Congress in 1935, the vote in the House was 372 to 33 and in the Senate 77 to 6.

One of the reasons people generally are so interested in old-age security problems is the progress of urbanization that has characterized our country in the last fifty years. In 1900, 60 per cent of the population lived in rural areas. In 1950 the figure was 41 per cent. When we were predominantly an agricultural nation, a large proportion of our old people could be taken care of by their families on the farms. The houses were large enough for the purpose and there were usually useful odd jobs to occupy the older members. Furthermore, many of the necessities of life were produced on the farms.

With the vast growth of the city population

* Also privately printed by the author.

and the decline in the rural population, a marked change took place. City homes had less space and the old people did not fit into the family circle as they had been able to do on the farms. The proportion of persons dependent upon wages grew steadily. When wages stopped, the consequences were serious. That was indeed the situation in the depression of the 30's. It brought the American people quickly to the point where they hailed the entry of the federal government into the picture. And, judging by what has happened since, they will insist upon its remaining there. It is therefore important that we become aware of the potential dangers inherent in the Social Security program, acquaint ourselves with its features and lend our influence to keep it within bounds.

LEVELS AND TYPES OF BENEFITS

When our social security program was originally adopted, it was understood that the benefits should be set at a level which would represent a basic floor of protection. It was not the thought that the benefits should be set at the level of comfortable living. This should be achieved through the personal thrift and initiative of the individual. Sir William Beveridge, now Lord Beveridge, put it this way in his famous report in 1942: "The State in organizing security should not stifle incentive, opportunity, responsibility; in establishing a national minimum, it should leave room and encouragement for voluntary action by each individual to provide more than that minimum for himself and his family."

President Eisenhower, in his Social Security message to Congress in January, 1954, put it this way: "The [Social Security] system is not intended as a substitute for private savings, pension plans, and insurance protection. It is, rather, intended as the foundation upon which these other forms of protection can be soundly built."

In translating that principle into action, differences of opinion are bound to arise. Where should the line be drawn for the "foundation," the "basic floor of protection" or the "national minimum"? Under the present law, the maximum monthly benefit for a man aged sixty-five under the Old-Age and Survivors Insurance (OASI) system is $108.50; for a man and wife each aged sixty-five or over, $162.80; and for a surviving widow and two or more minor children, $200: In appraising the level of Social Security benefits, it should always be borne in mind that they are free of federal income taxes, whereas wages and salaries are not. Coming to the lower levels of benefits, those to a man and wife each over sixty-five will be 50 per cent or more of average wages where such wages do not exceed $289 a month, equivalent to $3,468 a year. This figure is interesting when compared with $3,300, the current median wage for covered workers in this country. That is to say, more than one-half of the workers earn less than $3,468 a year.

How do figures like the above square with the concept of a basic floor of protection? Many believe that they have already passed it. Others believe that they are below it and should be still further increased. In fact, some groups would go so far as to have the OASI system take over the major burden of old-age protection, relegating private pension programs to a minor role. These groups apparently do not fear centralized power in the federal government.

By the same token, other groups fear the fact that high levels of benefits greatly increase the power of Social Security as a tool that could be used to make the mass of people subservient to a centralized government. The man in the street wants security. He also wants freedom. What he does not realize is that security provided and administered by government may lead to a loss of his freedom. Hitler used the German social insurance system for his own ends. A friend of mine was living with a German family. Its head, an elderly man, was dissatisfied with the way things were being run in his town. When asked why he didn't try to do something about it, he replied, "Ah, my pension." The more dependent upon government a person becomes, the greater the potential jeopardy to his individual freedom. Returning to the particular situation in this country, it should be noted that the increases in benefits made just before the election last year were not necessitated by changes in the cost of living since the last preceding increase in 1952. If at each national election, benefits are to be raised because of political rather than economic considerations, this country is heading rapidly into a danger zone.

Old-age pensions are expensive things. For example, the maximum $108.50 a month to which a man may become entitled at sixty-five is then equivalent to a capital sum of $13,600. The $162.-80 to himself and a wife of the same age is equivalent to a capital sum of $22,960. Raising benefit levels by even apparently small amounts involves a lot of money and a potential heavy burden on the economy of the future. Under our present sys-

tem, as we shall see, increased benefit formulas can now be adopted with but little current burden on the economy. It is easy to make promises for our successors to fulfill. We are trying to force them to do what we currently are unwilling to do. This is one of the most dangerous characteristics of the present system.

In this connection, it will be well to consider the proposal being advanced that the benefit formula for OASI benefits should include a built-in escalator. It takes the form of advocating a yearly percentage increase in benefits—say one per cent for each year of participation in the plan. Thus, simply by this device the future benefit load on the economy could be 30 or 40 per cent heavier than at present, entirely apart from any changes in the basic formula that might be made in the meantime. There was such an incremental factor of one per cent in the benefit formula in effect from 1939 to 1950. Congress then saw the danger and removed it from the law. There are groups who will urge its reinstatement the next time the law is to be revised.

To support the proposal for an incremental factor in OASI, the analogy with private plans is sometimes advanced; but there is considerable question that such an analogy is apropos. It is true that private pension formulas involve factors increasing the pensions for each year of service with the organization. To provide for these increasing levels of benefits, however, advance funding is provided so that when the benefits fall due funds will be in hand to finance them. No such arrangement is contemplated in the OASI system when the incremental factor is advocated. For that reason the proposal involves a large element of irresponsibility. No one knows what the future course of the price level will be; nor what demands on the economy may develop. Under a social insurance program, the needs of persons of a given income status should be met on the same relative basis whether retirement occurs in the near or distant future. If conditions change and future adjustments in benefit levels become necessary, they can be made by Congress as was done in 1950 because of changes in the cost of living. To introduce an automatic escalator clause is dangerous. It could be extremely burdensome on the taxpayers of the future and lead to a breakdown in the program that would be damaging all along the line.

Another controversial feature in the benefit formula is the wage base upon which the taxes and benefits are computed. Originally, this base was $3,000 a year. It was raised to $3,600 on 1951 incomes and to $4,200 on 1955 incomes. What is the proper level? Some would raise it as high as $6,000. Others believe that it is now too high. It should be kept clearly in mind that an increase in benefits can always be achieved by a change in the formula without any change in the wage base. Simultaneous changes in *both* the formula and the wage base produce two sets of increases. First there is the across-the-board increase from the formula change. Second, there is an *additional* increase for all those receiving more than the old wage base. For example, the recent change in the base from $3,600 to $4,200 benefited only those receiving more than $3,600. Under a social insurance program, it is a fair question whether this is the income group which should be raised to higher benefit levels. Should not the lower income groups receive the greater attention?

Our OASI program involves a system of benefits graded according to the previously covered wages of the worker. Some countries, Great Britain, for example, use level benefits. Outside of the Townsend group, not many voices are raised in favor of level benefits for this country. Perhaps the most compelling reason for graded benefits is the wide spread in earning levels here. For example, in 1953 the per capita income payments to individuals in this country averaged $1,709. For the lowest state the figure was $834 and for the highest, $2,304. In selecting a single level figure for a uniform benefit, what would that level be? If it were set low, higher paid workers would find it unacceptable. If set high, not only would the burden of cost be serious, but the benefits would enable older persons in the low income groups to live in retirement in much greater relative comfort than those in the high income groups.

The Advisory Council appointed by the Senate Finance Committee to study the OASI program, in its report issued in 1948, put the case for graded benefits as follows:

> The Council favors as the foundation of the Social Security system the method of contributory social insurance with benefits related to prior earnings and awarded without a needs test. Differential benefits based on a work record are a reward for productive effort and are consistent with general economic incentives, while the knowledge that benefits will be paid—irrespective of whether the individual is in need—supports and stimulates his drive to add his personal savings to the basic security he has acquired

through the insurance system. Under such a social insurance system, the individual earns a right to a benefit that is related to his contribution to production. This earned right is his best guaranty that he will receive the benefits promised and that they will not be conditioned on his accepting either scrutiny of his personal affairs or restrictions from which others are free.

I believe that these principles are being recognized as eminently sound for a country like ours.

ECONOMIC BURDEN AND ESTIMATES OF COST

Another interesting, far-reaching subject is the burden the country should be prepared to support in caring for its dependent groups. We are today concerned primarily with the aged population. However, the large number of dependent children cannot be overlooked. During the last two generations, there has been a marked change in the relationship of the number of non-working persons to those who are working. As an approximate indication of this change, we may consider the working group to be those aged twenty to sixty-four, inclusive. Taking first the children and going back to 1880, we find that then there were 99 children for each 100 in the working group. This figure fell sharply until 1940, when it reached a low point of 59. In 1954 it was 64. While the proportion of children was decreasing, the opposite was true for the group aged sixty-five and over. In 1880 there were 7 persons in this group for each 100 in the working group. This figure has gone steadily upward and today it is 15.

For the two dependent groups taken together, the 1880 figure was 106. This declined to 70 in 1940. In 1954 it had risen to 79. Thus, the total dependency index which fell steadily for the 60 years prior to 1940, and contributed to the increasing prosperity of that period, has now turned upward—an important fact to bear in mind.

It is a truism that the standard of living of a country is dependent upon the amount of goods and services produced. Likewise, the standard of living of any group in the population is determined by the share of goods and services it receives and applies for its own use. Should the living standards of the dependent groups be above, below, or on a par with those of the working group? Is it not essential for the total production of goods and services to be increased, not only that the average living standards of the entire country may be raised, but also those of the dependent groups? To accomplish these increases, what average rate of capital formation will be required? What should be done about the length of the work week in order to avoid having increases in capital facilities nullified by fewer man-hours of work? In the allocation of production as between the young and old non-producing groups, which should be favored? This problem has already been before the electorate in more than one state.

Questions of this kind are bound to arise as we contemplate the burden on the economy imposed by changes in the level of production and in the relationships between the producing and dependent groups. For many years, as we have seen, the relative size of the non-producing group declined. Now that this trend has been reversed, another situation is being created. We have not time to go into all of these problems in detail. They are enumerated because of their importance and general interest.

Another factor in connection with the burden involved in supporting the aged is the number in the group who are working and contributing to the support of themselves and their wives. Dr. Sumner Slichter, one of our distinguished members, has estimated that the production of persons in this category has a value of some $14 billion each year. Obviously, if this were not available, a heavy extra burden would be thrown upon the producing group. Entirely apart from psychological and other considerations connected with the employment of older people, it is helpful to have as many as possible contributing to their own support. All this has a bearing, too, on the prevalent practice in many places of compelling retirement at a fixed age as sixty-five. While retirement from a prior job at a given age may frequently be desirable, the provision of suitable work for older persons able and desiring to work is an important obligation of society.

Having discussed in general terms the burden of providing for the dependent groups, it will be interesting to consider in concrete figures the estimates of the cost of the OASI program. It is obvious that such estimates involve many assumptions as to the future. These assumptions include birth rates, death rates, marriage rates, levels of employment and wages, and ages at retirement, to mention some of the important ones. Obviously, there can be no accurate forecast of costs when so many uncertain variables are involved. Accordingly, the actuary of the Social Security Administration makes what he calls

"low-cost" and "high-cost" estimates. Thus, he obtains sets of high and low figures within which he hopes the actual results will fall. As we shall see, this method yields figures showing surprising differences as the projections extend to the distant future.

The most useful measuring rod for appraising costs is the percentage relationship of benefits to taxable payrolls. For 1955 it is expected that the percentage will be about 2.8. Looking ahead for sixty-five years, the low-cost estimates indicate a rise in this percentage to 7.9. The corresponding high-cost estimate is 11.8 per cent—half as much again. The graded payroll tax rates in the law are scheduled to rise by steps to a total of 8 per cent in 1975 and after. It is to be hoped that the low-cost estimate is near the truth.

Under the scale of taxes and benefits in effect in the past there has been excess of income which has resulted in the accumulation of a trust or reserve fund amounting now to about $21 billion. Looking ahead, the low-cost estimates indicate a fund of $263 billion sixty-five years hence, whereas the high-cost estimates indicate that the fund will have been exhausted in forty years—an amazing variation.

None of the estimates of future costs can do more than represent guesses. However, there can be no doubt that they indicate a heavy burden, increasing steadily for many years to come. Will the producing groups in the future be willing to pay, directly or indirectly, for the protection of the then aged, the equivalent of 8, 10 or 12 per cent of payrolls? We of this generation are not doing anything like that. Why do we believe that our children and grandchildren will be willing to do it? This is a serious question that will be discussed in a moment when we consider the Old-Age Assistance part of our Social Security program.

THE WORK CLAUSE

One of the controversial features of the OASI program is the so-called "work clause" or earnings test relating to the receipt of benefits under the program. In the 1930's, unemployment was widespread and there was a general feeling that one of the functions of old-age benefits was to remove old people from the labor market to enable younger people to find jobs. Therefore, it was provided in the 1939 Act that earnings of as much as $15 a month from covered employment would disqualify a person from receiving his benefit for that month.

As time went on, conditions changed and the country came to realize that the production of which older people are capable is a potential asset, and that there should be enough work available to provide jobs for all able and willing to work. Accordingly, the work clause has been liberalized until under the 1954 change a person may earn up to $100 a month in any field of employment without any effect upon his old-age benefit. Furthermore, if he has attained age seventy-two, his benefit will be paid without regard to what he may be earning.

Even this last liberalization does not suit many people who believe that the payroll taxes paid entitle a person to receive benefits at sixty-five irrespective of his current earnings. One of our leading weekly periodicals has editorialized vigorously on the subject.

In finding an answer to this question, a first step is to consider the function of the old-age part of the OASI program. Basically, it is to replace income that is cut off in old age. If there are sufficient earnings, then the contingency insured against has not arisen. Those who would pay benefits irrespective of earnings look upon the program as providing annuities to begin at a certain age, because they have been "bought and paid for" through the payroll taxes. They claim that the system puts a premium on not working, whereas old people should be encouraged to be usefully employed.

The solution of this problem is not easy, since there are points on both sides. If the annuity theory should be adopted, then every employed person upon reaching age sixty-five would receive an increase in income if he continued in his old job. Is that a desirable use of the funds of the Social Security program? Since the cost of the program is heavy to begin with, should it be burdened with this extra load? That it is not a negligible load is indicated by the fact that to do away with the earnings test entirely would add about $1.9 billion to the benefit load. Expressed in another way, the extra cost is estimated over the years to be equivalent to about 1.4 per cent of payrolls. When the normal cost got up to 8 or 10 per cent of payrolls, this extra load would loom very large in the taxpayers' thinking.

Another aspect of the proposal to do away with the work clause is worth noting. With benefits at levels now in effect, it is possible that persons over sixty-five, still in good health and de-

siring to work, would be willing to accept less than the going wage by substituting part of their OASI payments for a wage reduction. Thus, a man aged sixty-five with a wife of the same age, receiving $125 monthly benefits might be willing to accept $50 a month less in wages, since he would still be $75 a month better off in over-all income, without taking into account the income tax-free status of the OASI benefits. Labor would have something to say on this subject if the practice, under the pressure of economic conditions, should assume significant proportions.

The argument that benefits beginning without fail at age sixty-five have been bought and paid for falls down when it is realized that the OASI system has received in taxes, from or on behalf of the persons now receiving OASI benefits, less than 5 per cent of the value of those benefits; and in the extreme case of any individual, about 10 per cent. As time goes on, this percentage will rise. Thirty or forty years hence, it may be that the taxes a worker himself will pay will come close to paying for the benefits he or his family will receive, including old-age benefits on an annuity basis. However, until we get much nearer to that future date, we need not be concerned lest persons not receive in benefits, under the plan as it stands, far more than what they have paid for.

It should be noted in favor of the 1954 change that earnings in a month above $100 do not cause the loss of all benefits. The law now provides that for each $80 in excess of $1,200 earned in a year, a month's benefit may be lost. Benefits are never lost for months with $80 or less of wages and no substantial self-employment. This is a great improvement on the former plan which caused anything in excess of a month's earnings of $75 to cause a forfeiture of the entire month's benefit, no matter how large. A further improvement on the recent change would be to reduce benefits by the excess of the earnings over $1,200, thus avoiding the discontinuities resulting from the fixed $80 limit.

What the final outcome of the work clause discussion will be is anyone's guess. Although liberalization has political appeal, I am inclined to think that the prospective cost will be the determining factor. As the cost of the total program begins to pinch, and it will do that before long, the giving of an automatic raise in income to persons who work beyond age sixty-five may be quite unattractive to the taxpayers.

COVERAGE

With the amendment made in 1954, the OASI system now covers about 90 per cent of the gainfully occupied workers of the country who earn enough to meet the eligibility requirements. The remaining 10 per cent are to be found in the first four of the following groups:

Armed Forces	3,300,000
U. S. Civil Service	1,600,000
Policemen and Firemen	200,000
Lawyers and Doctors	300,000
Miscellaneous [1]	2,900,000

Railroad workers, about 1,400,000 in number, are indirectly covered under OASI (though on an unsatisfactory basis) through financial interchange provisions; by the guarantee that benefits will be at least as large as under OASI for those with ten or more years of service; and by the transfer to the OASI system of those who leave with less than ten years of service.

The Committee on Retirement Policy for Federal Personnel, the so-called Kaplan Committee which reported to the 83rd Congress, recommended that OASI coverage be extended to the first two groups in the above list. There appears to be a reasonable prospect that the members of the Armed Forces will be brought into coverage.

However, the prospects of such extension to Civil Service employees are not so clear. If such extension were made, the OASI coverage would provide the basic layer of protection. To that would be added such additional benefits as would be required to bring the levels of protection at least up to where they now are under the existing separate retirement systems. This would be comparable to what is done throughout industry where benefits supplemental to OASI are provided for employees. However, there seems to be a fear among Civil Service workers that they would not fare so well under a dual system as they would if they retained their own independent one. Because they are politically powerful, they appear to feel more confident of better special treatment if they remain aloof. From the point of view of the country as a whole and of those who go into and out of employment in the system, inclusion of the group in the OASI system would be advantageous.

[1] Most of this group are self-employed persons (including farmers and share croppers) whose net earnings are under $400 a year, and domestic and farm workers who do not earn sufficient wages from any one employer to meet coverage requirements.

When it comes to the professional groups such as lawyers and those engaged in some form of medical practice, we find a different situation. These groups, as represented by their organization leaders, desire to be left out of the OASI system. Perhaps the main reason is the belief that they will be able to earn substantial sums from their professions between ages sixty-five and seventy-two (when the work clause goes off) and hence would not be able to collect old-age benefits between those ages. This reasoning for a time kept life insurance agents working on commission from being included in the OASI program. They believed that after sixty-five they could earn more than the permitted amounts and hence would not benefit from it. This concept prevailed at the outset, but as the work clause was liberalized and survivorship benefits were increased and better understood, the attitude of the rank and file changed. The official position was reversed and today life insurance agents working on commission are included in the system. I would hazard the guess that it will not be long before similar forces will bring about a reversal of the present stand of the lawyers and medical men.

It should also be mentioned in this connection that the attitude of these professional groups may to a degree have been determined by another consideration. It is their hope that Congress will enact a law enabling self-employed persons to deduct, within limits, the amounts paid by them for private old-age retirement protection. Thus, it is argued, they would be more on a par with regular employees where contributions made on their behalf by employers under approved retirement plans are not taxable as income to the employees. There is something to be said theoretically for this position. However, the loss of tax revenue to the Government would be so great if the plan were adopted that it is likely to encounter strong opposition from those charged with balancing the budget in these days of huge outlays for defense.

THE RETIRED UNPROTECTED AGED

We come now to a subject which has generated much heat, even charges of dishonesty. It relates to what should be done about those aged sixty-five or over who are now retired but were never able to qualify for OASI benefits. A very few of these had reached age sixty-five before the Social Security law was enacted. Millions more had never been in covered employment, or, if they had, employment had not been such as to enable them to qualify for OASI benefits. What should be done about these groups?

To throw light on this question, consider what happens when an old, established business concern sets up a contributory pension plan for its employees. Those covered represent a wide range of ages and of years of service. Some, after long service, are close to retirement. Suppose each employee contributes a percentage of his wages and the company a like amount. For young employees their contributions and those of the employer as they accumulate over the years will in themselves provide the pensions to be paid when these employees retire. For the older employees, however, the yearly contributions will provide but a small fraction of the desired pensions. Accordingly, the company adds funds of its own to enable these old employees to retire on pensions comparable to what they would have received had the plan been in effect from the time they entered the business at young ages. In so doing, the company provides what are called "past service" benefits. The pensions actually paid to these older employees far exceed the pensions, sometimes called "earned" benefits, that would have been provided merely by the regular yearly contributions made after the plan was set up.

In setting up the Social Security system, something similar had to be done for the older workers who otherwise would have received totally inadequate benefits. As a matter of fact, the original 1935 law was so unsatisfactory in this regard that it was changed four years later to provide more reasonable benefits to those retiring in the early years of the system and to permit those aged sixty-one or more at the inception of the plan to qualify for monthly benefits—a group permanently disqualified in the original law. How were these larger early year benefits to be provided? It was by drawing upon the current payroll taxes being paid into the system by workers in covered employment and by their employers. In other words, the plan did not contemplate accumulating into a large fund the contributions of the younger workers against the day when they will be retiring.

Under this method of operation, the plan is not one of savings by which a worker's contributions are accumulated to provide his ultimate pension. It is a plan under which those working today make compulsory contributions (called payroll taxes) to a retirement program, which

contributions are used to provide benefits to the current retired aged included in the plan. In return, these workers will look forward to benefits in their own old age to be financed by compulsory contributions imposed upon the workers of that future day.

There are many who believe that it would have been valid procedure at the outset to have applied similar principles to provide benefits for all persons over age sixty-five who had then retired, provided the system had covered practically all of the gainfully employed persons in the country. Under such a system, a uniform Federal monthly minimum benefit would have been given to the retired aged and the individual states would have been encouraged to pay such additional amounts, based upon needs tests, as seemed necessary to the states. In this way, the varying conditions and living costs in different parts of the country would have been met. The merit of this plan would have been that the uniform basic Federal part of the grant would have been paid to the retired aged without being subject to the decisions of social workers guided by needs tests that vary greatly from state to state, far more than do the living costs or standards of living.

When the Social Security system was set up, it was not feasible to include all of the workers of the country. With no prior administrative experience, it was not practicable to bring into the plan several large groups, such as agricultural and domestic service workers and the self-employed, even if at that time they would have been willing to be included.

Accordingly, the best plan that could be thought of for those not covered was a joint federal-state program of Old-Age Assistance (OAA) under which grants were made to old people, the entire amount of which would be determined by needs tests in the various states. It was anticipated that this program would be largely temporary and that in the course of time OAA would decrease and the OASI system would carry nearly all of the burden of old-age protection. Originally, the financing of OAA was on a fifty-fifty basis by the federal government and the states. Over the years that ratio has changed, so that today the federal government now pays four-fifths of the first $25 a month of an individual's payment, and one-half of the next $30. On the average, of the $1.6 billion being expended annually under OAA, about $.9 billion is paid by the federal government.

One of the valid criticisms of the OAA plan is the marked variations in the needs tests of the various states. In New Jersey, for example, 4.6 per cent of those over sixty-five received Old-Age Assistance in June, 1954, whereas in neighboring New York the figure is 7.5; in California 25.8 per cent, in Louisiana 57.8 and for the country as a whole 18.4. In contemplating these wide variations, one cannot help wondering about the justice of having the federal grants dependent upon such different interpretations of need. Many believe that with the present wide coverage, it would be practicable and fair to do now what could not properly have been done at the start when coverage was much less, namely, to bring into the OASI system on a uniform basis, say $35 a month, all those retired aged not already drawing OASI or other federal old-age benefits. The states would then add what they felt proper under the conditions in their areas.

The mere suggestion of any such "blanketing-in" of these old people raises the cry that an attempt is being made to "wreck" the contributory system and to open the door to a politically motivated universal pension program financed out of general revenues. To many it is strange that persons who feel that way seem to disregard what was done under the railroad retirement program. When that was set up, many had already retired and were drawing pensions. What was to be done about the benefits for these persons, as well as for those who retired between the enactment date in 1935 and the first collection of contributions in 1937? Were they to be cared for by a separate system financed by special taxes? The answer was "no." Their pensions were taken over by the new plan and paid for out of the joint tax receipts from employers and employees. We have not encountered any charge that this was either dishonest, or that it did damage to the contributory concept, which is still functioning vigorously in the railroad program.

It will help to a better understanding of those who favor blanketing-in if we consider the exceedingly small tax payments that need be made under the OASI system to enable older persons to qualify for very large benefits. Going back to the beginning, take the case of a worker earning $200 a month who started contributing in 1937. Five years later, after having paid payroll taxes of $120, and his employer a like amount, he retired at sixty-five with a wife of the same age. Together they were entitled to old-age benefits of $55.13 a month. The value at that time of these monthly benefits on an actuarial basis was about

$7,700. In five months, they had received more than the $240 in taxes paid on their account. The system was indeed "contributory," but in the case of these old people the contributions were negligible when compared with the benefits.

Nor was this all. In 1950 those on the benefit rolls received gratuitous increases with no further contributions required. The above couple had their benefits increased to $91.50. Still again, in 1952, there was a further increase to $103.10, and finally in 1954 to $115.10. Adding the values of these gratuitous increases as of the times they were received, we arrive at a figure of about $5,500 which, of course, is in addition to the original $7,700 above mentioned—all in return for $240 in taxes.

The above example is by no means extreme. Take the case of a man entering covered employment for the first time at the beginning of 1955 and earning $200 a month up to July 1, 1956, by which time both he and his wife will have just attained age sixty-five. The man will have paid taxes of $4 a month, or $72 for the period and his employer a like amount. For these $144 in taxes, the OASI system will provide benefits of $117.80 a month while both are living. Thus, the taxes are more than covered by five weeks' benefits. The $117.80 a month, plus the reduced amount payable after one of the couple dies, has a present value of $16,400. With figures like this in mind, it is a bit difficult to claim that the contributory principle justifies such benefits and denies minimum benefits of say $35 a month to those who, through no fault of their own, were not included in the OASI system.

If the retired aged not included in OASI nor any other federal retirement program should be brought into the system, about 4.3 million people would be involved. Of these about one-third are men and two-thirds women. About 3.6 million, or 85 per cent, would be aged seventy or over. About 2.05 million are receiving Old-Age Assistance, and for them the federal grants would replace the federal shares they are now receiving indirectly through OAA. About 2.25 million would be brought in who are not now receiving OAA payments. The total annual cost for all would be just about $1.8 billion, or about twice the present federal share of OAA (to be replaced) now being paid from general revenues. The net *additional* cost would be in the neighborhood of $.9 billion a year, decreasing as the group of old people pass out of the picture and amounting to about $6 billion in all.

As a matter of record, it will be interesting to review the gratuitous increases made in 1950, 1952, and 1954 in the benefits of those who were already on the rolls. The aggregate amounts over the years, estimated as of the times the increases went into effect, are approximately as follows:

1950	$ 5.5 billion
1952	2.5 billion
1954	3.8 billion
Total	$11.8 billion

In the light of figures such as these, the $6 billion extra cost of bringing in the retired unprotected aged on a $35 a month basis after allowing for the savings to the federal government from OAA, does not appear unreasonable to those who favor the program under consideration. They believe that blanketing-in would be no more than fair when one considers the thin dividing line between being included and not being included in OASI; and that we would merely be doing justice by those who in their day contributed to the economic welfare of the country. These old people, 85 per cent of whom are over seventy, would then not be subject to the means test for the federal minimum. Since they will not be with us for many more years, the long-range costs of the OASI program would not be materially affected. However, current payroll taxes would be higher for a few years than if the present OAA program were continued.

There are some who would approve blanketing-in, provided the extra funds required were not taken from payroll taxes. These persons favor general revenues as the source of the extra funds, believing that that would place the program more on a par with the private pension analogy previously described. Because of the heavy demands of the cold war and of the burdens left by World War II, many believe that social insurance should be supported by special rather than general taxation and hence favor the use of payroll taxes.

One argument in support of charging the extra payments against payroll tax receipts, possibly by raising the rates sooner than now scheduled but to no higher ultimate level, is that even so on the average, the payroll taxes paid by individual *current* workers would not exceed what would be required to finance their own benefits on a true accounting basis; nor will they be as much as workers entering in the distant future would have to pay. Therefore, the extra burden

of blanketing-in could be looked upon as being more than covered by the employers' taxes. Individual workers on the average could not justifiably claim that their own contributions were being diverted and that they were being required to pay more than their benefits would be worth.

Another argument for blanketing-in made by those who favor the step is that the workers of this generation through payroll taxes should be willing to do for the current aged something comparable to what they upon retirement are expecting their children and grandchildren to do for them through the payment of payroll taxes. This would bring greater responsibility into the present OASI system. Because, as we have seen, OASI benefits now being paid are less than current payroll tax receipts, it is easy to change the benefit formula and place a heavy burden on the future without having to raise tax rates to meet current outlays. If through blanketing-in the retired unprotected aged were brought into OASI, benefit increases would have to be met by increased tax rates. Those now contributing to the program who naturally want it to stand up when the going gets tougher would do well to approve steps which would discourage the promising of more than can be delivered. It is obvious that much can be said on each side of this blanketing-in proposal.

THE ROLE OF OLD-AGE ASSISTANCE

As mentioned briefly before, the Old-Age Assistance program was adopted with the hope that it would be largely temporary. As OASI increased and took over more of the load, it was anticipated that the need for OAA would become progressively less and in due course be reduced to a very minor role. For a number of reasons that has not happened. One was the inflation of the 1940's, during which the needs of the old people increased in terms of dollars, so that assistance payments had to be raised to higher levels. Another was the inflexibility of the OASI system which was not adjusted to the higher living costs until 1950. Still another was the lack of full coverage of all types of employment in the original act. Accordingly, it was necessary for the small OASI benefits to be supplemented in many instances by OAA grants.

However, with the larger OASI benefits, the wider coverage and the easing of eligibility requirements brought about by the 1950, 1952, and 1954 amendments, one would naturally expect the OAA program to be showing signs of retreating to a minor role. However, such has not been the case. Although the number of OAA recipients has declined by some 8 per cent from the 2.8 million top in 1950, the total OAA expenditures per month have *increased* by about 8 per cent. Furthermore, the number of OASI recipients receiving supplementary OAA has increased from 276,000 in 1950 to some 500,000 now.

This tendency indicates a real danger for the future. It is that OAA will come to be looked upon as a permanent program designed to supplement the enlarged OASI benefits. As the law now stands, there is nothing to prevent a state from supplementing an OASI benefit of large size by an OAA grant. For example, a couple might be receiving $125 a month from OASI and apply for OAA. An additional $25 a month could be granted to each by the state with $20 (four-fifths) paid by the federal government. Only five dollars a month apiece would have to be paid by the state. The grants could exceed $25 a month with the amount over $25 (not to exceed $30) borne fifty-fifty by the federal government and the state. This development was not anticipated when OAA was established and careful consideration should be given to its possible consequences.

In both Massachusetts and California, for example, 33½ per cent of the OAA recipients in February, 1954, were receiving OASI benefits. Viewed from another angle in Louisiana, 45 per cent of the OASI beneficiaries were getting OAA payments. In Colorado the figure was 31 per cent and for both Oklahoma and Missouri 29 per cent. Unless something is done to meet the situation, we may end up with a permanent "double decker" system involving OASI benefits as a base and supplementary OAA grants awarded on an extremely lenient appraisal of needs. In fact in some states the OAA might come to be awarded almost on a regular pension basis with very little regard to need. This could be a state politician's "dream"—to promise the electorate a $25 "pension" on top of OASI at a cost to the state of only twenty cents on the dollar!

As a first step toward meeting this situation the law should provide that all OAA payments to those receiving OASI benefits should be shared fifty-fifty by the federal government and the states. The present plan of having the Federal Government pay 80 per cent of the first $25 of monthly benefits provides a strong incentive to states to use the program for political purposes

at a very moderate cost to themselves. Old-age pensions cost a great deal of money and unless held within reasonable bounds can turn out to be an exceedingly heavy burden on the economy of the country. The original program of having OAA retreat into the background as OASI took over the major burden of old-age protection was eminently sound. Many students of the subject are deeply concerned about the current trend and believe it should be vigorously dealt with.

TAXES AND RESERVES

We have already pointed out that the OASI system is not a savings plan, but one involving compulsory contributions (payroll taxes) to a retirement program. The current receipts, except for the amounts that have been retained to accumulate a contingency reserve, have been used to pay the current benefits of those already on the rolls. Incidentally, this contingency reserve, known as the trust fund, now totals about $21 billion. That sounds large to most of us. Yet it is about $13 billion short of the amount that would be needed to pay the future benefits of those already on the rolls. From that point of view not a dollar of savings is on hand to provide benefits for those who will retire in the future.

In this connection there is little doubt that many people in this country have an idea that the contributions they are being compelled to make to the OASI system are being saved up to help pay for the benefits they will some day receive. As already indicated, that is not the case. If a true savings plan had been adopted, only a small fraction of the taxes thus far paid could properly have been paid out in benefits. Instead, nearly all would have been accumulated and the trust fund, instead of being about $21 billion, would have been about $34 billion. More than that, a savings plan of the kind indicated would contemplate an ultimate reserve or trust fund of the order of $250 to $300 billion.

During the period that this accumulation of funds was taking place, the general revenues of the government would have to bear a very large proportion of the cost of the OASI benefits currently being made. Thus there would be a double burden on this generation of workers. First, they would be paying general taxes to provide large sums to finance OASI benefits to current beneficiaries under the program, and second, they would be paying payroll taxes which would be accumulating a huge fund to provide their own future benefits as they fall due. That double burden is more than we could expect this generation to assume voluntarily. Unfortunately for the next generation, the ultimate burden we are planning for them to bear may prove to be relatively as heavy then as the unwelcome double burden would now be for us. The outlook is not too comfortable. Caution is clearly indicated in the making of any promises of further benefit increases unless we ourselves are willing to shoulder corresponding burdens.

In connection with the above conclusion that the accumulation of a huge trust fund will not be undertaken, it may be pointed out that there are other reasons supporting that position. For one thing the impact on the economy of the country would be marked if so large a proportion of funds that would otherwise be spent for consumers' goods were invested in government debt—either new debt or in old debt transferred from present public holders to the trust fund. Merely to mention this problem is to raise many far-reaching questions with which we cannot deal here.

Then there would be the problem of protecting the system from benefit raids of one kind or another. Seeing very large amounts going into the trust fund, which would be increasing steadily to astronomical levels, could lead to irresistible demands for liberalizations of benefits that could eventually wreck the whole program. The average man simply would be unable to see the logic of allowing so much money to be locked up in government bonds.

It is the impracticability of the alternatives that compel the OASI system over the years to be operated on a substantially pay-as-you-go plan. In other words, a savings plan of operation is not practicable.

One of the present difficulties with our program is that the OASI system has not yet reached the pay-as-you-go stage. Benefit payments are still less than the payroll tax receipts—the difference going into the trust fund. Already this situation has facilitated the increasing of benefits since the added burden bears so lightly on the taxpayers now.

How large should the contingency reserve or trust fund be? That is a question upon which there will be differences of opinion. The measuring rod that appeals to me would relate it to the amount of current covered payrolls. For example, these now total about $160 billion, including earnings by the self-employed. Perhaps it

might be reasonable to aim at a fund equal to say 15 per cent of payrolls which now would mean that $24 billion should be in the fund. Once the desired level had been achieved the payroll tax rates could be adjusted to accomplish the desired objective. If payrolls declined, the fund could be drawn upon to meet the additional load on the system that would probably be experienced concurrently. This additional load would arise from the decreased payroll taxes and a probable increase in retirements which would step up benefit payments.

I think there is general agreement that a contingency fund should be maintained in a program of this kind. Perhaps the best way to arrive at a decision about its amount and the attendant financing problems would be to have a qualified advisory council appointed to study the subject and make recommendations to Congress.

The problem of the type of taxes to finance the OASI program has controversial aspects. By good fortune the payroll taxes have had wide acceptance. Labor has favored them and individual workers are willing to pay their shares. This no doubt stems from the close relationship between taxes paid and the individual benefits to be received. This gives a greater feeling of confidence than if benefits were financed out of general revenues that, of course, are under heavy pressure to meet the large costs of defense and other items in the budget. Earmarked tax receipts provide greater assurance that the Social Security obligations will be honored when due. The average worker looks upon the benefits as having been "bought and paid for." To go back on such an obligation would have exceedingly serious political consequences.

During the early 1940's, as the initial tax rate was repeatedly "frozen" instead of being increased as scheduled, amendments to the Social Security Act provided for possible future tripartite financing of the benefits. That is to say the benefits eventually would be provided by payroll taxes paid by employers and employees with eventual supplementary appropriations from general revenues, if needed. This did not materialize since payroll taxes have more than covered all benefits. Then in 1950 amendments were enacted, providing for the OASI system to be financed solely through payroll taxes, including, of course, taxes on the incomes of the self-employed included in the program.

This course was no doubt dictated largely by the tremendous increase in the demands made upon the general budget by World War II and its aftermath. Acting under a sense of responsibility for the uncertainties of the future, Congress felt it sounder to provide that OASI benefits be financed out of taxes not involved in the general budget. This decision was I believe wise. The heavy tax burden on corporations and individual incomes is already proving to be a drag upon the expansion of the economy upon which depends our ability to provide jobs for new workers and to increase our living standards. Is it not better to lighten the tax burden on the producers of wealth and the creators of jobs and instead to rely to a greater extent on the taxation of wealth after it has been produced? With this question and its controversial ramifications we will leave the reader to make up his mind as to the proper source of revenue to finance OASI benefits.

NATURE OF THE RESERVES

We come now to what to me is one of the strangest of the controversial facets of the Social Security problem. It relates to the nature of the reserve or trust fund accumulated in the OASI system and invested in government bonds. Some of these bonds are public issues of the type available to anyone and can be sold by the fund directly to the public. Most are bonds especially issued by the Treasury to the fund and are not directly salable to the public. That makes little difference, however, since they are redeemable by the Treasury, which in turn can sell regular bonds publicly to obtain the needed redemption funds.

The three trustees of the OASI trust fund are members of the government, namely, the Secretaries of the Treasury, of Health, Education and Welfare, and of Labor. Because of this fact frequent charges are heard that the OASI trust fund is a fraud because it consists simply of IOU's of one branch of the government to another; and that because the money represented by the bonds has been spent, future taxpayers will have to pay again to provide interest and principal. On the surface this sounds convincing, and millions have been misled by it. We shall attempt step by step to get at the truth of the matter.

First, the fact that the trustees are members of the government is irrelevant. Suppose it had been arranged that a Social Security Life Insurance Company, with private individuals as directors, had been set up to run the OASI system.

The payroll tax receipts would be paid to the company which in turn would pay claims and expenses and invest the excess of income over outgo in a reserve fund. The government in turn would guarantee to maintain tax rates at a level that would enable the company to operate in the black. It would also be provided that any reserve funds would be invested solely in U. S. government bonds.

Had this plan been carried out, the company, like any other life insurance company, would invest its excess income in interest bearing securities. The difference would be that a regular company would invest only a part of its funds in government bonds, whereas the special company would be limited entirely to them. If a regular company had invested all of its funds in government bonds it is not conceivable that it would have been assailed as unsafe because the government had spent the money it had received upon the sale of its bonds to the company. The mere formulation of the charge shows how fantastic it would be. And yet that in essence is what is charged because the OASI trustees have invested their funds in government bonds.

It is strange that this charge should be made against the OASI trust fund and not against the many other government trust funds invested in government bonds. Among these are the reserve funds of the government life insurance issued in connection with World Wars I and II, the funds representing Postal Savings deposits and the reserve funds constituting the unemployment trust fund. The bonds in these funds are tangible assets which are being bought and sold by the funds as circumstances indicate. When it comes to dealing with these government bonds, those who own them find them to be extremely valuable assets, and are not concerned that the government had "spent the money."

When, however, it comes to the OASI trust fund the complexion of the government bonds seems to change. They become mere paper IOU's given by one branch of the government to another. Suppose the trustees need to realize a billion dollars on their bonds. They sell the bonds to the Treasury, which in turn sells bonds to the public. The bonds produce for the fund the extremely tangible asset of a billion dollars in bank, and the public has the equivalent of one billion of the old bonds, the proceeds of which had been spent. Do the public holders of these new bonds have to lose sleep because of that fact? Merely asking the question shows how silly it is to suggest that the government bonds in the OASI trust fund are basically different from any other government bonds. One feels apologetic about devoting so much space demonstrating what should be obvious in the first place. Unfortunately, thousands have been misled by reasoning, honestly presented, but completely unsound.

In considering the investment of excess income it should be pointed out that it is advantageous to the government, when it has to borrow, to have OASI funds available. For one thing it is less inflationary than having to borrow from the commercial banks. Again it reduces the amount of borrowing from savings institutions and individual savers, thus increasing the volume of savings likely to be invested directly in private production facilities. The excess OASI income loaned to the government represents money that to a very large degree would not have found its way into capital investment, but rather would have been spent for consumer goods.

It is sometimes claimed that the OASI reserve funds should not be invested in sterile government bonds but directly in securities which build up the productive capacity of the country. Obviously, this question has far-reaching implications. Are we prepared to embark on a program which would bring production facilities under government ownership? So long as this country believes in free enterprise and not in national socialism it will reject any such proposal. The cure would be worse than the disease. This question as to the future may be largely academic since it will not be many years before the outgo of the OASI system overtakes the income, leaving little or nothing to invest.

Looking at the OASI system as a whole, once a reasonable contingency reserve has been accumulated, it is probable that the best interests of all would be served by having income and outgo in substantial balance. This would mean a minimum of borrowing of OASI funds by the government or of liquidation of bonds by the fund. The OASI requirements, if of large magnitude, could have deflationary or inflationary consequences at variance with the then current economic needs of the country.

DOUBLE TAXATION

The final of the controversial facets with which we are concerned relates to the charge of "double taxation" previously noted in passing. It is charged that the country is forced to pay

OASI taxes, a considerable part of which are later invested in government IOU's. To pay interest on these IOU's and finally to pay the principal, other taxes must be raised. This, it is claimed, is unjustified double taxation.

The first step in getting at the truth of the matter is to realize that the OASI taxes are special purpose, and not general, taxes. Although they are not actuarially computed as are the premiums of a life insurance company they nevertheless have a resemblance to premiums for future benefits. Furthermore the longer the system remains in force the closer the resemblance will become, since the contributions that will have been made by workers now young will come close to providing the benefits to which they will become entitled. When there is an excess of income over outgo the trustees invest it in government bonds under the provision of the law.

Consider the situation where the OASI trust fund for example would own $20 billion of 2½ per cent government bonds yielding $500 million of interest a year. If the government had not borrowed this $20 billion from the fund it would have done so from the public so that it makes no difference to the general taxpayers in whose hands the bonds may be when it comes to raising general taxes to pay interest and principal.

However it makes considerable difference to the OASI operation when $20 billion of government bonds are in the fund. The time is likely to come when OASI benefits and expenses will exceed then current tax receipts; and then the $500 million of interest will be available to help meet the outgo. Were it not so available but being paid to others, payroll tax rates would either have to be increased or there would have to be a subsidy from general taxation to make up for its absence. When the bonds are held by the OASI trust fund the general taxes raised to pay the $500 million of interest serve a dual purpose. They pay the interest which would have to be paid in any event and in addition make it unnecessary, to the amount of the interest, to raise payroll taxes or to draw upon general revenues to meet OASI outgo. Thus the holding of government bonds by the OASI trust fund in reality *prevents* future double taxation. The original double taxation charge is thus found to be without any foundation whatsoever.

The foregoing ten areas of controversy are the main ones likely to be encountered as amendments to the OASI program are proposed. Total and permanent disability benefits provide another exceedingly controversial subject and are sure to be considered when the next revision of the Social Security Act comes before Congress. However, disability coverage is not related primarily to the old-age security problem. Furthermore it involves so many considerations that a whole paper could be devoted to it alone. It is hoped that what has been presented about the old-age features of Social Security will help to clarify a number of points in that important area of social insurance.

REFLECTIONS ON THE DESERTION OF THE INTELLECTUALS

CRANE BRINTON

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(*Read April 21, 1955*)

SOME years ago I rashly attempted, under the title of *The Anatomy of Revolution*, to make a comparative study of the old regimes in England, the British North American colonies, France and Russia just before the great revolutions in these countries. One very obvious common factor in all four regimes I called, following a lead from Lyford P. Edwards's *Natural History of Revolution*, the "desertion of the intellectuals." By this I meant that in seventeenth-century England, eighteenth-century America and France, late nineteenth- and early twentieth-century Russia the bulk of those who at the higher levels of culture wrote, taught, preached, acted on the stage, wrote and played music, practiced the fine arts—and the bulk of their audience—clearly felt that the government, the political, social, and economic institutions under which they lived were so unjust that a root-and-branch reform was necessary. To put it simply, these intellectuals were disloyal toward existing legal authority. That at least for the intellectual leaders of the English, American, and French revolutions this disloyalty now seems to most of us loyalty to something higher and better than the existing legal authority is true and important, but for the kind of sociological analysis—indeed diagnosis—I have tried to make, not directly pertinent. For this kind of analysis we must face the fact: Benjamin Franklin, for instance, by temperament by no means the acid intellectual in revolt, was a traitor to his king. Indeed Franklin himself, who was that rare thing, a revolutionary with a sense of humor, recognized this truth in his famous remark that he and his colleagues had better hang together, or they would all hang separately.

Ever since I began to study this problem, however, I have been troubled by a grave difficulty. I still think I am right about the "desertion of the intellectuals" in those four societies at those four moments; what troubles me is the question, just what is, in a Western society, the normal attitude of the intellectual classes toward the way their society is run? How far in a stable, or reasonably stable, society do those who write, preach, teach, and practice the arts behave like pillars of that society? I can here do no more than attempt to set up some signs toward a possible investigation of that problem, a problem which, like most major problems of sociology, seems to my historian's eye to need the depth and perspective that only comparative historical analysis can give.

There are many difficulties in the way of such a study. The historical record is most imperfect from the point of view of the retrospective sociologist, largely because those who made that record did not usually ask themselves the kind of questions he asks. There are, moreover, in such tasks as properly defining "intellectual" and "intellectual classes" and in defining "normal," difficulties no less grave for the fact that thinkers have been grappling with them at least since the Greek philosophers first broached the problem of universals. I must say here, however, by no means parenthetically, that unless we do succeed in giving to "normal" and "stable" some kind of meaning, some general direction in a process in time, there will be no sense at all in this kind of inquiry. Then there is the need to distinguish between the great figures and the near-great, who have survived as the staples of our cultural history, and the many, many not in their day quite mute, but still inglorious, Miltons—the lesser and usually, perhaps, more conventional, less rebellious intellectuals. And these must both be distinguished from their audiences.

Above all there is the obvious difficulty that among the majority of intellectuals at all, or at any rate most, times and places there must be noted and weighed a normal component of discontent with things-as-they-are. You will remember the story of how, when he was told that the transcendental Miss Fuller had said that she accepted the universe, Carlyle commented, "Gad, sir, she'd better!" Of course we can all see now that neither Carlyle nor Margaret Fuller for a moment accepted the universe—certainly not in the sense, for instance, that the practicing scien-

tist, while he is being a scientist, has to accept the universe. But I can perhaps make clearer what I mean by this normal variation of the intellectual from the rest of mankind in attitudes toward things-as-they-are if I ask you to compare the standard performances as *observers* made by the most self-effacing, the least hortatory and improving, of "realistic" novelists and those made by just ordinary bird-watchers. I grant you at once that the novelist has a much tougher job, indeed a quite different job. Man-watching is harder than bird-watching. A large part of the difference, however, lies in the fact that the bird-watcher knows quite well that he cannot change the behavior of the birds, but the man-watcher, and, I am afraid, also the man-questioner, always cherishes some shred of hope that he can change the behavior of men.

Finally, we shall be at least less imprecise in our attempt to decide what is the normal attitude of intellectuals toward the society of which they are a part if we use as a measuring rod, not their attitude toward life, ideals, the universe, or anything quite so grand, but simply their attitude toward those in power in their society, toward its "ruling class," toward those who bear the burden of responsibility for running that society. In this way we avoid the difficulty that comes from trying to measure and judge loyalty and patriotism. I do not know whether Plato loved Athens or Voltaire, France; both surely were aware of, were moved by, the greatness of these societies; but, in my specific definition, both were intellectuals who had deserted.

At the very outset of the course of Western history there is a very neat contrast between the intellectual who has not deserted and the one who has. The Pericles of the famous Funeral Speech clearly feels that his Athens is a going concern; the Plato of the Republic, and indeed of most of the works, quite as clearly is sure that Athens is not a going concern, or rather, that it is going to the dogs. And here too we find some of the further difficulties in the way of our search. It may be inaccurate to list Pericles as an intellectual, though the tradition has certainly long emphasized his great cultural interests; it may even be inaccurate to consider the Funeral Speech as made by Pericles, though here again Thucydides, who reports it, seems like an honest as well as an able man. And Plato may never have been near enough to the real Athens to have deserted from it; that is, he may have been so completely the philosopher as the vulgar see the philosopher, the man so completely above mundane things as not really to be a part of them. But this too seems to me unlikely. I think Plato hated and feared the democrats who ran Athens in his day. At any rate, here at the start of our historic culture are two documents, both enshrined in our tradition as classics. One directly praises the existing regime; the other not so very indirectly damns it. And they are only a generation apart in time.

With Augustus we come to an era in which the great writers are mainstays of the regime. Here, as later in England under Elizabeth I and in France under Louis XIV, there is a chorus of praise for the prince. The intellectuals, far from deserting, accept the regime loyally; indeed, they have seemed to many in that vicariously and comfortably rebellious century of the intellectual nonconformist, the nineteenth, to have fawned on their rulers. Yet clearly many of these writers of the golden princely ages by no means lacked the capacity for discontent and profundity we expect from our great humanists. Shakespeare, I think, would in an unstable society have been in the forefront of the deserters; and Horace would at least have jeered from the sidelines.

Then there is the instance of the happy, conforming intellectuals of the high Middle Ages in the West, the scholastics at the height of their achievement in the twelfth and thirteenth centuries. These thinkers are by no means really agreed on many matters; the range and depth of their disputes on such fundamentals as the problem of universals are very great indeed. And among them are individuals who display the characteristic marks of the heroic—or if you prefer a quite different approach, the neurotic—rebel intellectual. Abelard, surely, would have been at home with Voltaire, and indeed with Lord Russell. Yet if the high Middle Ages do not on inspection look quite as serenely one-minded as they can be made to look by a writer like Henry Adams, so uncomfortable in our many-minded age, they still display, I think, an intellectual class which accepts without serious question the social and political structures under which it lives. By the time of Piers Plowman, Wiclif, and the *Jacqueries,* to say nothing of that fifteenth-century Huizinga has called the "Autumn of the Middle Ages," the intellectuals have indeed begun to question these structures, have begun to desert.

All this seems to add up to something pretty simple after all. The intellectual classes, judged by their works, seem actually good barometers, or good litmus paper. The test is simple: in a stable,

healthy society the intellectuals support the existing regime; in an unstable society threatened with revolution they turn against the existing regime. Their behavior is a fairly reliable indication of how a given society is developing. Unfortunately, at least from the point of view of the contemporary student of society, this simple formula will not work. At any rate in the last few centuries complications have arisen in the social status and in the attitudes of the intellectual classes which need study and definition.

Since time is short, I propose to try to state briefly some of these problems of the status and behavior of the intellectual classes in the United States, where I think it is not clear now, and has not been clear for several generations, just to what extent these intellectuals have accepted their country as a going concern. And, of course, there is the related problem of how far non-intellectual Americans accept the intellectuals as good fellow countrymen. Among the intellectuals—with whom I am here chiefly concerned—feelings of fear, anger, and righteous indignation have reached recently a pitch that the historian must feel reminds him of the kind of social tension that in the past has marked societies on the edge of revolution. I think there are good signs that the most acute stages are past for the moment, but the basic question does remain: have American intellectuals deserted? That they almost certainly feel that they have *been deserted* is, though important for the full study of the situation, not immediately germane for this paper.

There are surely some signs that the American intellectual tradition is nearer to that of Plato than to that of Pericles. From Jonathan Edwards to Mr. Lewis Mumford and Mr. Archibald MacLeish the number of gifted American writers who have judged the behavior of the mass of their fellow countrymen unfavorably—I deliberately use a weak and colorless phrase—is perhaps rather higher than usual in a modern Western nation. But of course we have no statistical evidence on this matter, no "index number of righteous indignation," and the attempt to make one would seem undignified to the humanist and most unscientific to the scientist. I shall have to rely on the hunch and on the isolated example. But surely it is no accident that an American writer destined by birth and environment to be a contented conformist if there ever was one—I refer to James Russell Lowell—could make so epigrammatic a statement of the eternal complaint of the acid intellectual: "Truth forever on the scaffold, Wrong forever on the throne." May I here suggest that there can hardly be a clearer indication of the existing, and perhaps inevitable gap between the processes of natural science and those of humanism than the translation of this sentiment into: "the higher always beneath the lower."

Again, it would seem clear that the more successful American writers, to judge success by survival and by current attention paid them, have felt that the wrong people have usually run this country. The formula is simple and well known: since the foundation of the Republic, or since 1812 or 1840 or at best 1865, businessmen and their hired intellectuals, the lawyers, have ruled in politics, economic life, and social life, leaving culture to their womenfolk and the unhappy but unhired intellectuals. These free intellectuals have replied by damning the businessmen as crude, blundering, narrow-minded materialists, betrayers of the promise of American life. Here again my report is colorless; but you all know how colorful the originals are.

One variation of this attack on businessmen our intellectuals share with their European fellows—the attack on the middle class, or bourgeoisie. This attack with us Americans lacks the intensity and the bitterness of some European group-hatreds. Sinclair Lewis seems to have had a good sound ambivalence toward George F. Babbitt; indeed he rather liked Babbitt, and certainly liked Dodsworth. I do not think Gustave Flaubert ever liked any of his characters—including himself. Still, if American writers rarely work themselves up to the pitch of expressing the hope that the last bank president will be strangled with the bowels of the last advertising man (I paraphrase a famous expression of the eighteenth-century Enlightenment in France), their dissatisfaction with bourgeois culture is widespread and continuing. Nor does success help. Actually, as we all know, success—money-making success—in our culture is for the unhappy intellectual who gets trapped into achieving it simply the surest of all the many ways that used to lead him to Communism and now can hardly lead him elsewhere than to the analyst's couch. His guilt cannot otherwise be expiated—short of revolution.

Finally, there is the fact of the very great distrust felt by many ordinary Americans for the intellectual classes in this country today. I do not wish to add to the alarums we have already had over this matter; enough has surely been said by more eloquent voices than mine. But I will remind you that the sequence of slang terms

by which intellectuals have been known in modern America—highbrow, longhair, egghead—is an expressive and symptomatic one. If, to borrow from Arnold Toynbee, the American intellectual classes really are a "creative minority," then their relations with the masses are not described by that happy state Toynbee calls "mimesis," heartfelt, loyal, affectionate imitation.

I have already suggested that this alienation of American intellectuals from the masses of their countrymen is not unique in the modern world. It exists in various forms and intensities throughout the free Western world, and has existed for the last few centuries. Think how few of the great Victorians, in an age we like to think of as conformist, self-satisfied, and awfully lucky, really expressed the comfort and serenity they ought to have felt. Some, like Carlyle, Matthew Arnold, John Mill, seem almost as desperate as if they were living in our own wastelands. And think of any Victorian intellectual daring to amend Wordsworth—as I fear the objective man-watcher would have to—"Getting and spending we—enjoy ourselves!"

Now, to revert to my earlier attempt to use the degree of alienation of the intellectuals as a barometer of major social change, it might look as though this very general dislike our American and European intellectuals feel for the world they live in amounts to what I have called the "desertion of the intellectuals," and is in fact an indication that Western society is unstable, ready for real, thoroughgoing revolution, and not just in one country. Such, actually, though in different terms and from a different approach, is what Spengler, Sorokin, Toynbee and other philosophers of history have been saying. And they may be right.

I do not think so. Here, at least, I forbear inflicting on you a self-analysis of ultimate reasons why I think as I do. Sufficient that I cannot really feel myself in the midst of the decay and death of culture, nor even, what is more to the point in this paper, in the midst of an unstable society ripe for violent revolution. Even with some 16,000,000 unemployed at the depth of the depression, one did not feel in the midst of an unstable society. In conclusion, I shall try to give reasons why I do not think that, even if American—or French, or British—intellectuals have deserted, we are on the eve of a revolution anywhere in the West. They are in part mutually contradictory reasons, for the intellectuals are not a monolithic block; and moreover, even the individual intellectual is surely at least as full of good modern ambivalences as anyone else. It should be clear that in all I say I assume no third world war in the immediate future; the effects of such a war on social and political stability are simply not calculable.

In the first place, the desertion of the intellectuals is no single, absolute, determinant of instability nor even, to vary the metaphor, a single sure symptom of such instability. It is one of many variables historical experience shows are present in unstable societies. To be at all confident of a diagnosis of instability in a contemporary society one would have to note many other symptoms, such as grave financial difficulties, more than normal governmental snafu, more than normal public indignation at such conditions, and a lot more I cannot here go into. I do not see these other symptoms today—not even in France.

Second, though I think it an over-statement that revolutionaries, intellectuals, or plain people need a clear plan of what they intend to put in the place of the regime, the society, the way of life they attack, I do think the revolutionaries need to *feel* that they know what they want; they have to have a revolutionary faith. They do not need a theology—that will come later; they do need a good vague but urgent eschatology. Such our eighteenth-century ancestors had in what Carl Becker called the "Heavenly City of the Eighteenth-Century Philosophers"; such the Marxists have—or, in Russia, had, for it must there have lost by now its urgency—in the "classless society." But our Western intellectuals in the free world today have no such eschatology. In common language, they don't know what they want; they know what they don't want, but such knowledge is not really enough for an effective revolutionary.

Third, and very briefly, for it is a complex matter on which we really know very little: it may be that the relatively recent alienation of the intellectuals from the masses is, if regrettable, not in itself in any short term very significant for social stability. Perhaps the many simply accept, with an occasional few following an occasional McCarthy, the otherness of the intellectuals, and refuse to worry about them. Burke compared the English Jacobins with the grasshoppers of the field, whose noise wasn't even noticed by the magnificent, most symbolically English cattle at pasture. Burke himself, of course, was an intellectual, and he didn't really believe this, or he would

not have worried himself into the grave over English and other Jacobins. Still, he may have been right in his original analysis. I really do wish to make this point humbly, and in no spirit of debunking: we just don't understand the relation between, say, the *Partisan Review*—or indeed the *Kenyon Review*—and life in Ottumwa or Mattawamkeag. There may be no relation.

Finally, and especially for America—though I think this is basically true throughout the West—the intellectuals are not really alienated from bankers, businessmen, and politicians in just the way my revolutionary generations were alienated from kings, tsars, nobles, gentry, and prelates. It is not merely that, as I have just noted, the intellectuals in the West have no intense new faith, now that Marxism appears to have run its course. They really share, at bottom, the faith of their fellows. They may resent the Cadillac, but they like the Ford—well, perhaps with a little less chromium. They aren't, for the most part, really tortured even over life in Yoknapatawpha county, or in Boston. Some of them, deep down, perhaps even doubt one of the cornerstones of the intellectual's belief, succinctly expressed by Thoreau, that most men lead lives of quiet desperation. Some of these intellectuals despair—though by no means quietly—simply because they have heard talk of despair. Many of them, if you catch them unawares, look as though they were enjoying themselves, and not merely enjoying their unhappiness. In fact, if I may return for the last time to a symbol I have perhaps used too much, it begins to look nowadays in our perspective as if Sinclair Lewis and George F. Babbitt were brothers, under the skin.

THE EYE AND ITS STRUCTURAL ADAPTATIONS

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(*Read April 22, 1955*)

AMONG my biological colleagues, my name for a period of forty years has been specifically associated with the field of experimental embryology. Throughout this period, however, I have collected and studied, from time to time, the eyes of animals as a sort of scientific avocation. These have been studied primarily through the eyes of an anatomist. It might be well, therefore, at this juncture to fortify myself by advising you that my lack of training in many of the scientific disciplines does not permit me to speak with any authority about the problems of physiological optics, the biochemistry of the visual processes, and many other intriguing physiological aspects of visual functions.

The eyes of all vertebrate animals are constructed upon a common architectural plan. The sensory portion in all cases arises from the forebrain of the embryo. On the other hand, the surface ectoderm devotes itself entirely to the formation of the dioptric apparatus. Vertebrate eyes are composed of three concentric tunics or layers (fig. 1). The outer, including the sclera and cornea, is designed for protection and also for the entrance and refraction of light. The middle tunic is highly vascular and thus nutritive. It also exhibits regional modification to subserve the function of accommodation, and to control the amount of light entering the eye. The inner or receptor layer, the retina, is inverted, in that the receptor elements are turned away rather than towards the source of illumination. Thus, the light must travel through the nervous layers of the retina before reaching the photosensitive or light receptor cells.

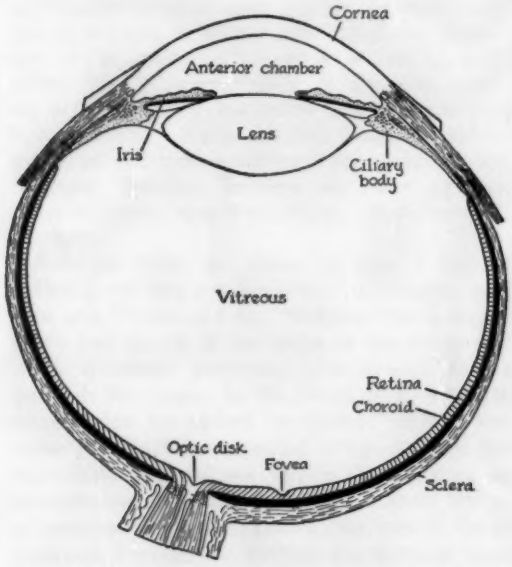


FIG. 1. Schematic horizontal meridonal section of right human eye.

Despite this fundamental structural scheme which is characteristic of all vertebrate eyes, nature has produced many deviations from the common plan with respect to the light collecting apparatus, the focusing devices, the light receptor elements and the nervous transmitting pathways.

As far as the eye is concerned, within the evolution of vertebrates, we find such things taking place as (1) an increase in the number of visual elements per unit area, (2) the appearance in the retina of a central region, highly differentiated, with a specially sensitive area centralis retinae or fovea centralis for high visual acuity, (3) the gradual swinging forward of the eyes in the head so that the visual fields are made to overlap—thus making possible binocular rather than panoramic vision, (4) a partial decussation or crossing of the optic tracts or nerve pathways to the brain which provides for the development of stereoscopic vision, and finally (5) the elaboration of a visual brain cortex over the more primitive olfactory cortex, thus making possible the capacity for intelligent appreciation of complex visual patterns and the power to form reasoned visual judgments—a vital evolutionary accomplishment in helping to establish the intellectual supremacy of man. Further, with respect to the general scheme of evolutionary ascendency, it may be pointed out that it does not involve a steady and

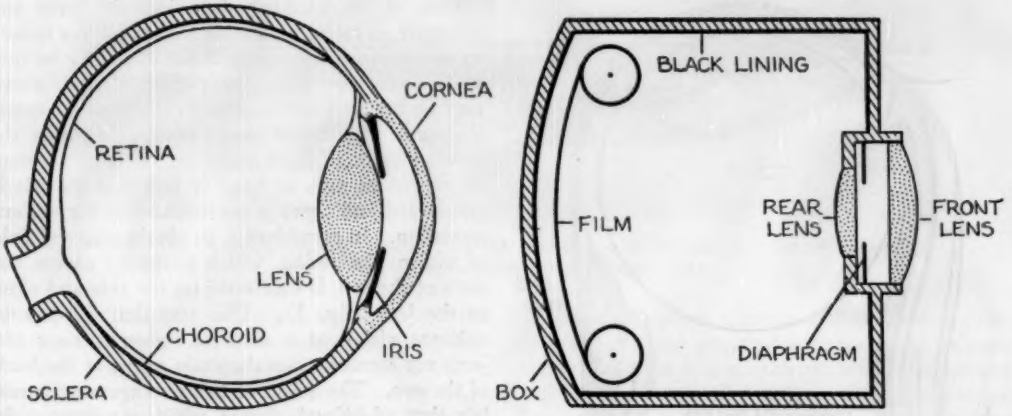


FIG. 2. A comparison of the eye and the camera. The cornea and lens correspond to the front and rear lens in the camera; the iris corresponds to the camera diaphragm; the choroid corresponds to the black lining of the camera; the retina corresponds to the film; the sclera corresponds to the box.

gradual increase in efficiency as far as the human eye is concerned. One of the triumphs in ocular evolutionary achievements reaches its culmination in the reptiles and birds, especially the latter where the large eyes are equipped with a more effective focusing apparatus, and a more complex macular system in the retina subserving higher visual acuity. These forms, however, despite their more efficient receptor mechanisms, lack the cortical connections such as man possesses, and thus they do not share with man the capacity for reasoned visual judgments and interpretation. The eye of man, therefore, cannot be considered as representing the acme of efficiency as an optical instrument. Its functional predominance may be said to be dependent upon its connection with the unique and transcendent evolution of the associated visual cortex, rather than its precision as an optical system.

The eye, designed by nature, and the camera, designed by man, have some striking resemblances as are shown in figure 2. Each possesses a front and a rear lens. In the eye the front lens is represented by the transparent refractive cornea, and the rear lens by the lens proper. Between the two lens systems, whether in the eye or in the camera, an iris diaphragm is installed to control the amount of light entering the optical system. Both are lined with a coating of black material (in the eye, melanin pigment) to absorb stray light which would otherwise be reflected back and forth and obscure vision. The camera is focused by mechanically moving the lens towards or away from the light-sensitive film; in the eye the distance between the lens and the retina is constant, and focusing is accomplished by the ciliary mechanism which alters the thickness or anterior-posterior diameter of the lens—thus changing the focal point. Both in the eye and the camera, the lens system projects an inverted image of the surroundings upon a light-sensitive film (retina, in the eye). In the camera, the initial steps in taking a picture depend upon the decomposition by light of a photosensitive substance, silver bromide, suspended in a colloidal gelatinous film; in the eye the initial steps likewise depend upon the decomposition of a photosensitive substance in the visual receptors, visual purple or rhodopsin for the rods and iodopsin for the cones. Only here the decomposition products must be rapidly resynthesized; otherwise we would take one look upon the world and that would be all!—just as a stationary film in a camera takes only one picture. We now know that this photochemical breakdown and resynthesis employs the use of proteins, the caretenoid pigments and certain stereoisomers of vitamin A—a chemical system admirably worked out by Professor Wald and his collaborators at Harvard University, but too complex to consider further in this presentation.

The size of the eye varies greatly among vertebrates. Amphibians and reptiles have small eyes; fishes and birds have large eyes. The eye of the eagle is larger than that of man, and some of the hawks have eyes as large as the human eye. There is no constant relation between eye size

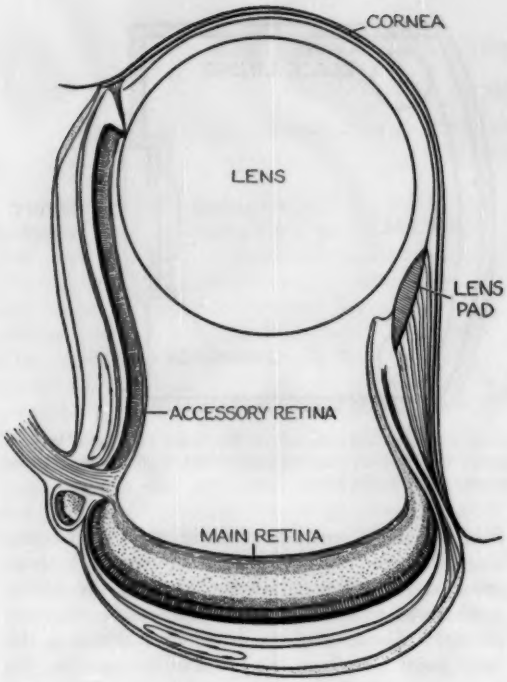


FIG. 3. Drawing of eye of Dissomma anale, a deep sea fish, showing an accessory retina lateral to the large spherical lens. Redrawn from Wolff ('54) after Brauer ('08).

and body size. The eye of the antelope is said to be larger than that of the elephant, and size seems to be dependent to a greater degree upon the nimbleness of the animal's movements and its necessity for acute vision rather than upon its bulk.

One of the striking deviations in form and structure to meet environmental conditions is seen in the deep sea fishes where the eyes may be said to be telescopic or tubular. Such shapes, which may be adopted for reasons of economy in space, impose a very limited visual field. To gather the small amount of light available, the lens assumes an enormous size, so large in fact that the iris is eliminated and there is no mechanism for accommodation. In some forms, to obtain a lateral field of vision, the retina, which normally covers the back of the eye, is continued up the side and close to the lens (fig. 3). This situation appears to enhance vision at a distance, whereas near objects are focused upon the main retina at the back of the eye. The effect of this arrangement parallels that of bifocal glasses which we require in presbyopia. Some of the tubular eyes of deep sea fishes are directed upward while others are directed forward (figs. 4 and 5). Whereas fishes, on the whole, have their eyes on the side of the head, the forms with tubular eyes possess binocular vision, which undoubtedly gives them an advantage when endeavoring to perceive spots of light at a reasonable distance.

One of the most remarkable structural aberrations among the eyes of teleost fishes is seen in *Anableps anableps*—the so-called "four-eyed" fish (fig. 6). This minnow swims at the surface of quiet waters. The eyes have two pupils—one for air vision and one for water vision. The eye is so placed that the water line cuts it in two. The lens is pyriform in shape and the curvatures used in looking through the lower submerged pupil are sharper than those employed by the superior or air pupil. Aerial and aquatic objects are focused simultaneously upon separate regions of the retina

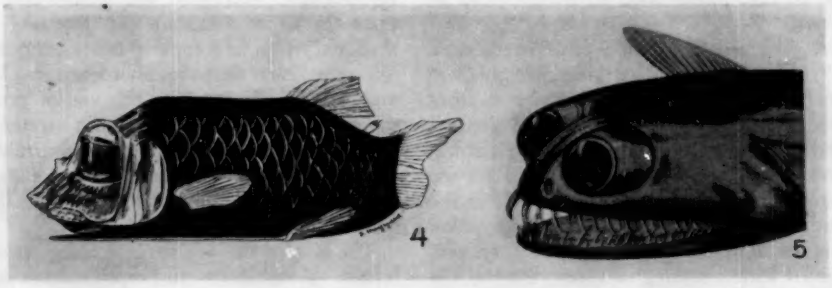


FIG. 4. Deep sea teleost fish (*Opisthoproctus soleatus*) with vertical tubular eyes. Photographed from Walls ('42), after Brauer ('08).

FIG. 5. Deep sea teleost fish (*Gigantura chuni*) showing horizontal tubular eyes. Photographed from Walls ('42), after Brauer ('08).

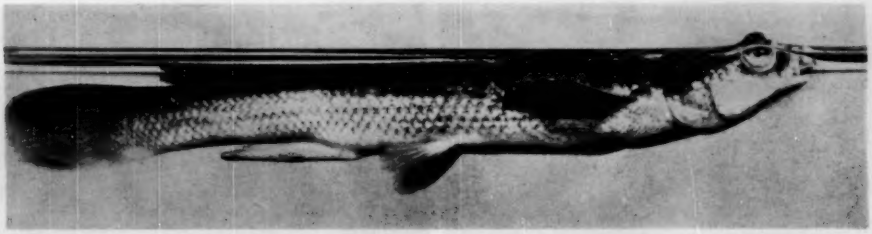


FIG. 6. The so-called "four-eyes fish," *Anableps anableps*, with divided pupil for air and underwater vision. Photographed from Walls ('42).

(fig. 7). This is a truly amphibious eye. But there are other teleost fishes with constantly submerged eyes, except for occasional leaps out of the water, which have excellent out-of-water vision. One of these is the archer-fish (*Toxotes*) which spits a tiny stream of water at an overhead insect, knocking it down to the surface film of the water, thus rendering it incapable of escape. With respect to this creature, Walls ('42: 435) says ". . . if the hydraulic artillery of the archer-fish is dependent upon what he can see through the surface below, he must have a truly remarkable trigonometric rangefinder in his brain to cope with the every-varying distortion of angles, sizes, and distances."

Another interesting pair of fish eyes is seen in *Periophthalmus* which is one of the mud-skippers of the coast of Asia, West Africa, and Polynesia. Their eyes are encased in high turrets (fig. 8) and move as though provided with universal joints. The eyes rotate under secondary spectacles or coverings which apparently protect the corneas from dessicating.

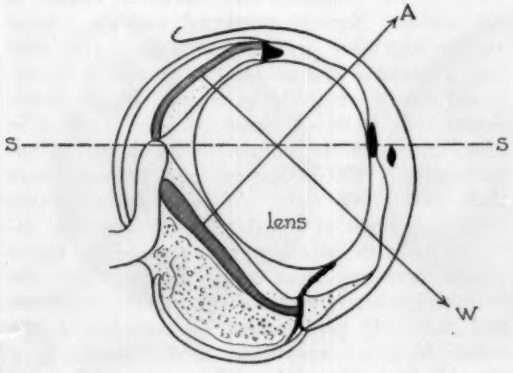


FIG. 7. Vertical section of the eye of *Anableps anableps* (fig. 6). A-line of sight into air; W-line of sight into water. Retina is indicated by lines. Redrawn from Walls ('42: 434).

Numerous other extreme and fascinating aberrancies as found among the fishes could be mentioned here, but it is not the purpose of the presentation to give a detailed account of the eyes in any one group, but to consider in an elementary way some of the interesting deviations in other groups as well.

Whereas many animals possess an optical apparatus which subserves reasonably well both day and night vision (so-called arhythmic forms), there are numerous animals, many within our experience, which are active only at night and which we designate as nocturnal. Others are active only in bright light and become inactive as nightfall approaches. These we speak of as diurnal forms. This functional dichotomy is based primarily upon a fundamental difference in retinal structure, but with it are associated some striking differences in the dioptric mechanism. This dichotomy is well illustrated not only by the reptiles and the birds, but by mammals as well. We are all acquainted with the well-known fact that, with respect to their habits, many of our feathered friends may be designated as day birds or night birds. Cer-

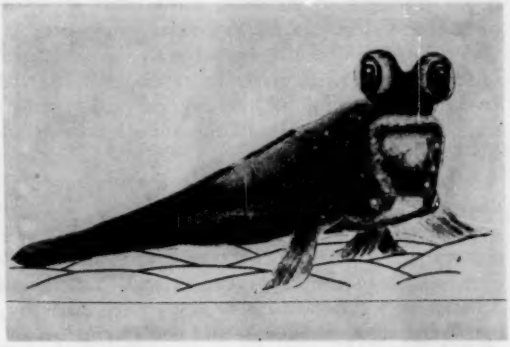


FIG. 8. *Periophthalmus koelreuteri*, a mud skipper, showing eyes set in high turrets. Photographed from Walls ('42: 431).

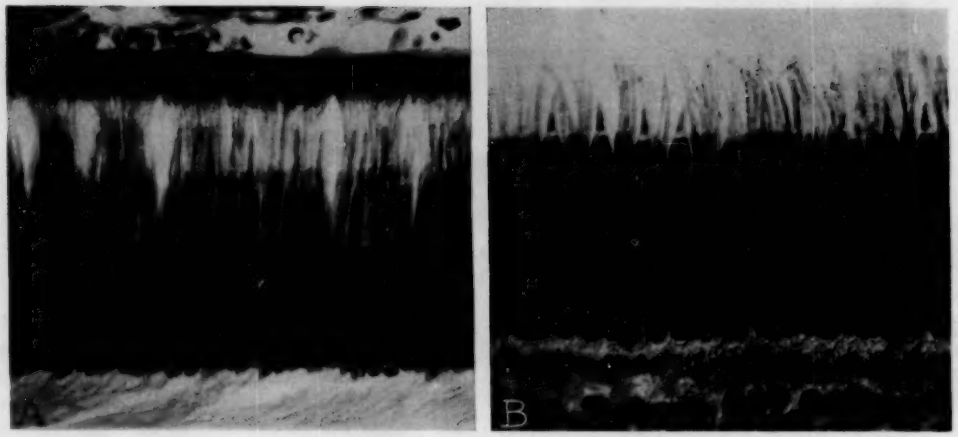


FIG. 9. Photomicrograph of the isolated retina of the rhesus monkey (*Macaca mulatta*). (A) parafoveal region, showing elongated cones and rods (× 630); (B) region near the ora serrata showing preponderance of rods and sparse, short stout cones. × 500.

tainly it is within the experience of anyone who goes from the city into the country in late spring or early summer to realize that, as dawn begins, birds become so active as to be either a delight or a source of annoyance to the individual, depending largely upon his temperament. Who also has not experienced the pleasure of hearing the solemn call of the whippoorwill as nightfall approaches? It is also within our experience that our domestic neighbors, the rats and mice, are much more active at night than in the daytime, and they rarely show themselves in bright light. The lemurs, a group of primate animals just below the anthropoids in the evolutionary scale, are essentially nocturnal in their habits, as are many lizards and snakes, and there are many features about the eyes in all these forms that go with nocturnal living. In fact so closely correlated is the mode of life of the animal with the structure of its eye, and particularly its retina, that from a critical examination of the eye one can predict something of the habits of the animal as well as its visual ability.

In 1866 Max Schultze made the fundamental discovery that the retina, particularly that of man, possesses two types of visual cells or photoreceptors, the rods and the cones, and that these elements subserve different visual functions. Further elaboration of his findings were made by the Frenchman, Parinaud, and the German, von Kries, and led respectively to the theory of the double retina of Parinaud and the Duplicity Theory of von Kries. The duplicity theory which is no longer theory but fact, implies that the rods are concerned with colorless vision at low intensities of light (scotopic vision) and that the cones constitute the apparatus concerned with vision at high intensities and with color (photopic vision). The cones are not assumed to be utterly useless at night but are relatively so because the majority possess thresholds which are much higher than the highest thresholds of the rods. The rods, however, which have low thresholds are apparently not entirely useless in daylight. The veracity of the duplicity theory has not only been proven innumerable times by physiologists in the laboratory, but nature itself has produced ample evidence of the structural and functional duality of the retina. Strictly nocturnal animals possess retinas which are primarily or entirely rod bearing, whereas in diurnal animals the retina is composed chiefly or solely of cones. In arhythmic forms both types of visual cells are present in abundance. In the human retina there are approximately 7,000,000 cones and perhaps more than 100,000,000 rods. As in all foveate forms with both types of visual cells, the rod-cone ratio varies as we pass from the center of the retina where there are cones only (the fovea) to the periphery where cones are very sparse or absent and the rods predominate. Examples of the retina from an arhythmic form (monkey), a diurnal form (turtle) and a nocturnal form (night lizard) are shown respectively in figures 9, 10, and 11.

Nocturnal forms are not only characterized by

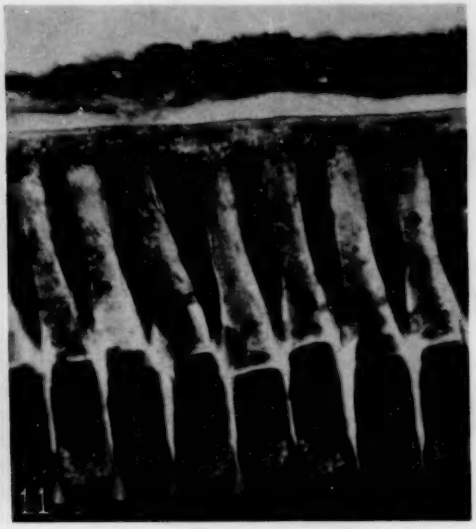


FIG. 10. Photomicrograph of the cone retina of the turtle (*Chelopus guttatus*). × 900.

FIG. 11. Photomicrograph of the pure rod retina of the nocturnal gecko (Gecko swinhonis Güeuther). × 1200.

an essentially pure rod retina, but the eye, constructed for nocturnal vision, exhibits other adaptive modifications. These consist of large extensively curved corneas (figs. 12, 13, 14), and large anterior chambers (figs. 15 and 16). Such a situation combined with a wide open pupil permits the gathering and refraction of oblique light and increases the periscopic ability of the eye. With large anterior chambers, the optical center of the eye is moved further back. The deeper the optical center within the eyeball, however, the smaller and brighter the image will be. Yet, the farther back the optical center is from the pupil the larger the pupil and the cornea must become so as to maintain a wide-angled field of vision. In addition to the large highly curved corneas and

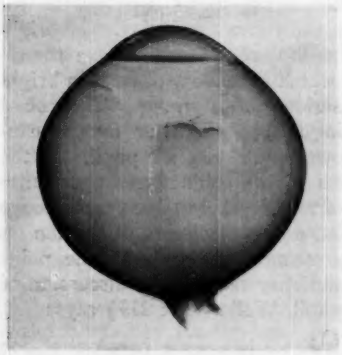


FIG. 12. Drawing of human eye to show relatively small corneal segment in relation to scleral segment (table 1). × 1.7.

FIG. 13. Drawing of the Chinchilla eye showing relatively large corneal segment (table 1). × 3.2.

FIG. 14. Drawing of the eye of Tarsius spectrum to show extreme size of corneal segment. × 2.4.

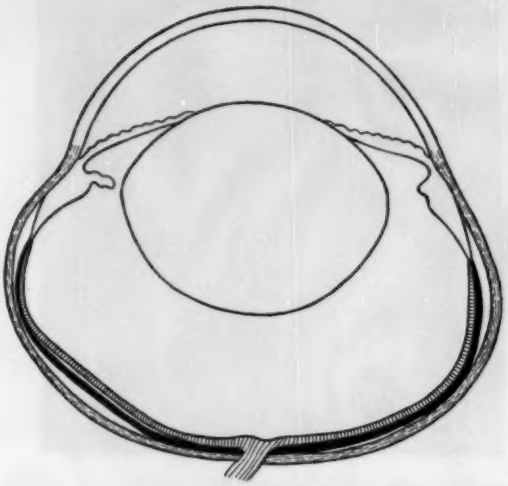


FIG. 15. Diagrammatic drawing of the eye of the nocturnal lemur (*Galago mala*) showing large anterior chamber and prominent spheroid lens. × 6.

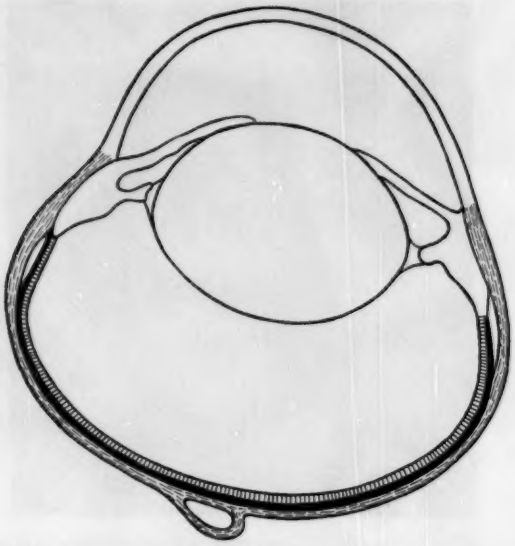


FIG. 16. Diagrammatic section through the eye of the nocturnal lemur (*Nycticebus tardigrada*) showing large anterior chamber and large spheroid lens. × 5.4.

large anterior chambers, the lenses in nocturnal forms are larger and tend more towards spherical shapes than in the diurnal and arhythmic forms. This is not only a characteristic of the nocturnal lemuroid eyes, but is especially so in the eyes of rodents. In the eye of the opossum, the rat, and the nocturnal gecko, the lens is spherical, as it exists in fishes.

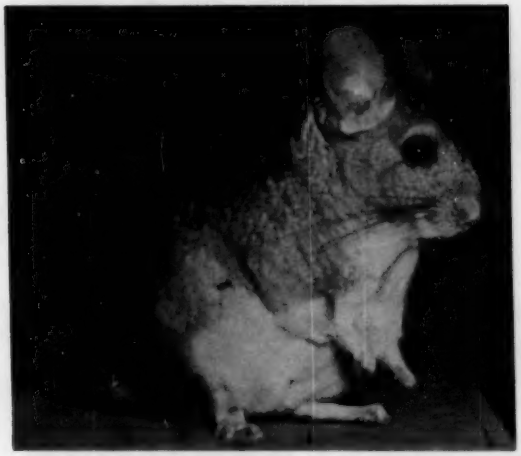


FIG. 17. Photograph of the Chinchilla (*C. lanigera*) showing extremely heavily pigmented iris.

Another feature of many nocturnal animals is the presence of a slit pupil which is usually vertical in position. Since many other nocturnal animals possess round pupils, in common with diurnal and arhythmic forms, it is apparent that the slit pupil has nothing to do with nocturnal vision, for under conditions of very dim light the slit becomes a round pupil. Nocturnal forms such as the rat or mouse, which are content to stay out of bright light, get along with a round pupil, but a round-pupilled animal which endeavors to bask in bright light suffers a serious disadvantage. The round pupil with a ring-shaped sphincter muscle cannot be closed down as far as a slit pupil. In the latter, in addition to the sphincter, the presence of two bundles of muscle fibers which cross above and below the slit, exerts a scissors-like action on the pupil, compressing it laterally to the point where it may completely close. In a discussion of the vertical slit pupil, Walls ('42: 219) says:

> The slit pupil is hence in a sense paradoxical, for although it is an adaptation to nocturnality, it has nothing whatsoever to do with seeing in dim light. Hosts of nocturnal species do not have such a pupil, and are well able to see under scotopic conditions.

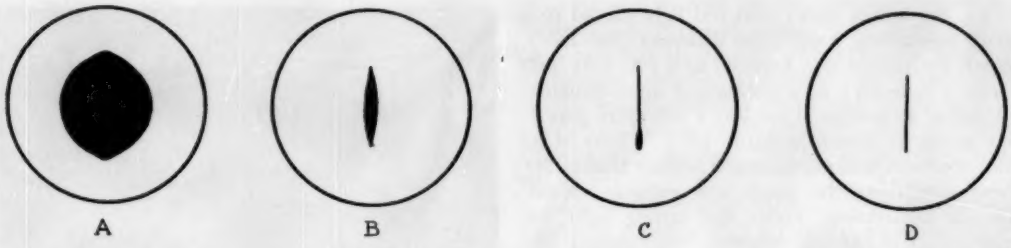


FIG. 18. Drawings showing the pupil of the Chinchilla in (A) dark-adapted eyes, (B) under red light (Wratten safelight, series O), (C) under laboratory daylight, and (D) under illumination from a 100-watt bulb at 15–18 inches distant.

They get along with a circular pupil because they are content to stay out of bright light. Any strongly nocturnal, rod-rich animal which cares or dares to venture out in the sun—whether a cat stalking the barn-yard sparrow, a Gecko seeking flies, a snake seeking warmth, or a shark basking at the surface—needs a slit pupil and will be found to have one.

Recently I have had the opportunity of studying the eye of the chinchilla—a much cherished fur-bearing animal endemic to the Andes mountains of Chile, Peru, Bolivia, and the Argentine. The relentless and continued hunt by trappers almost brought these appealing and benign creatures to extinction. Their introduction into the United States in 1923 by Mr. Reginald Chapman, a mining engineer, initiated a wide-spread chinchilla culture in this country. My interest in the chinchilla was not motivated by any pecuniary considerations. It was stimulated by a statement from a fancier that these animals are nocturnal in their habits.

Through the cooperation of Mr. Oscar Kraus of the American Chinchilla Corporation, I was able to observe the eye of the living animal (fig. 17) in my laboratory, and Mr. Karl Hagen of the Chapman Chinchilla Farm in California shipped me a goodly supply of preserved eyes, sufficient to enable me to make thorough histological studies.

The enucleated bulb, free from adnexa, has a form not unlike that of an acorn (fig. 13). The bulb, as is characteristic of most nocturnal forms, possesses a large corneal segment in relation to the size of the scleral segment. The perimeter of the sclera is only 1.5 times that of the cornea. In this respect the eye of the chinchilla and that of the laboratory rat are very similar. The size of the cornea in relation to total eye size is larger than in the nocturnal lemurs, *Galago*, and *Nycticebus*, but not as large as in the nocturnal *Tarsius*, also a tree-dwelling primate. The lens was found to be strongly biconvex—approaching a spherical shape, but not as large in relation to total eye size as is the lens of the rat. The relative size of the various components of the eyes of the nocturnal rodents (rat and chinchilla), the nocturnal lemurs (*Galago* and *Nycticebus*), several anthropoids, and man, are given in table 1. An examination of the table shows that *Aotus*, which is a true monkey, but nocturnal, fits in with the characteristics of the other nocturnal forms rather than with the arhythmic anthropoids and man.

One of the most interesting features of the chinchilla eye is the presence of a vertical slit pupil, which in darkness became almost round (fig.

TABLE 1

SHOWING RATIOS BASED UPON COMPARATIVE MEASUREMENTS OF THE EYES OF RODENTS, LEMURS, AND ANTHROPOIDS

	Ratios				
	A		B		
	Cornea: sclera	Cornea: whole eye	Lens: vitreous	Lens: whole eye	Anterior chamber: whole eye
Rat	1:1.4	1:2.4	1:1.0	1:2.6	1:2.5
Chinchilla	1:1.5	1:2.5	1:1.3	1:3.0	1:3.4
Galago	1:2.0	1:3.0	1:1.6	1:4.0	1:2.8
Nycticebus	1:1.9	1:2.9	1:2.3	1:5.0	1:2.8
Aotus	1:2.0	1:3.0	1:3.7	1:7.1	1:3.8
Marmoset	1:4.1	1:5.1	1:9.3	1:12.8	1:15.2
Rhesus monkey	1:3.1	1:4.1	1:7.1	1:10.0	1:17.0
Man	1:4.5	1:5.5	1:9.0	1:12.8	1:15.8

Measurements were made from horizontal or meridional sections.

A. Based upon linear measurements in inches of eye sections at a magnification of ×11.

B. Based upon planimeter surface area measurements of structures indicated at magnification of ×10.

18A), but which under dim red light closed to a shape resembling a marquise diamond (fig. 18B). When the animal was exposed to a 100-watt bulb (with a reflector) at a distance of approximately 18 inches, all one could see was a very dark pencil-like streak as shown in figure 18D. Those of us who observed this phenomenon believe that under these conditions the pupil was entirely closed. To our amazement, under this strong light for approximately fifteen minutes, the animal remained completely quiescent. There were no attempts to avoid light, either by closing the lids (which are motile) or by moving away from the source of light. When the light was turned off and the animal was exposed to ordinary laboratory daylight, the pupil opened up slightly at the ventral pole so as to resemble a tear drop in shape (fig. 18C). This small aperture is indeed a stenopaic pupil. Despite a well-developed ciliary body, the chinchilla lacks a ciliary muscle but by virtue of his ability to close the pupil to a pinpoint aperture, his capacity to form sharp images at varying distances is apparently quite good. Although some animals with a slit pupil can reduce it to a single stenopaic or pinpoint aperture or several tiny apertures (e.g., Gecko) there is only one known animal as far as I know with a "pinhole-camera" eye. This is found in *Nautilus*, a spiral-shelled mollusk (fig. 19). Such an eye has the advantage of being in focus at varying distances from the object being viewed. It has the disadvantage, however, of admitting a very small amount of light to the retina. Whether a slit pupil closes to a single or several pinpoint apertures, each serves as a stenopaic aperture, forming a sharp image as though the cornea and lens were not present, and so makes accommodation unnecessary. It should be pointed out, however, that some forms with a round pupil, and which cannot be closed to a pinhole aperture (e.g., the rat), also lack an accommodating mechanism with the consequence that their capacity to form sharp images is not so good.

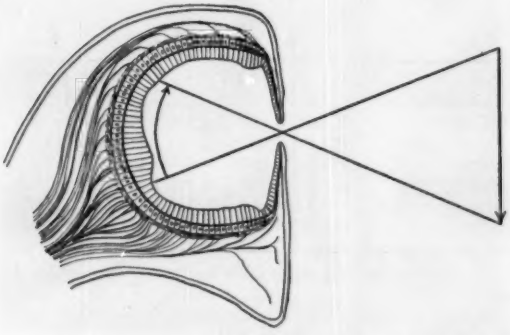


FIG. 19. Schematic drawing of the lensless, pinhole camera eye of the mollusc, *Nautilus*.

FIG. 20. Photograph of the slow moving loris (*Nycticebus tardigrada*) showing large cornea, and vertical oval pupil.

The ability of the chinchilla to close the pupil completely in strong light, plus the presence of a very densely pigmented iris, makes it quite possible for this strongly nocturnal animal to bask comfortably in the sunlight which it loves to do. This habit is shared also by the strongly nocturnal snakes which bask in bright light, and they too have vertical slit pupils. Since all nocturnal animals with a slit pupil possess a rod retina with very low visual thresholds, they have the necessary extra sensitivity in their retinas to make vision fairly bright despite the small amount of light entering the eye when the slit is closed down.

In contrast with the complacency of the chinchilla when under strong light, a definite avoid-

ing reaction was exhibited by the nocturnal lemurs (*Galago* and *Nycticebus*) but these forms, although possessing a vertical oval pupil, lacked the ability to close it down so completely. Furthermore the iris diaphragm was observed to be much less heavily pigmented as compared with the iris of the chinchilla. This is apparent from a comparison of figures 20 and 17. We are all aware of the fact that, regardless of maximal pupil closure, human albinos lacking iris pigment are extremely photophobic.

The retina of the chinchilla is composed of rods only and exhibits all the characteristics of a typical nocturnal receptor apparatus.

We usually think of the pupil as regulating the amount of light which will enter the eye and strike the photoreceptors. Indeed in many forms this is true, especially in birds, mammals, and man, which possess a duplex retina. However in lower forms such as the teleost fishes and amphibians where the pupillary response is either nil or very slight, a mechanism exists for adjusting the eye to changing illumination. This involves the so-called photomechanical changes in the retina. In bright light the cones contract, the rods elongate, the epithelial pigment migrates down over the rod outer segments to shield them from strong light. Thus the cones are made accessible to the strong light, presenting optimum conditions for their illumination (fig. 21A). In dim light or darkness, the rods contract, the cones elongate and the pigment contracts back towards the body of the cell. Now the rods become available for the weak light and the cones have moved out of the way (fig. 21B). Such a device may well serve forms with sedentary habits and deliberate movements, for the reactions are slow—requiring from forty-five minutes to an hour for completion. However, the slow speed of this reaction would seem to be detrimental to forms which may pass quickly to extremes of illumination. Here a rapid pupillary response is undoubtedly a better mechanism for adapting the eye. It so happens that the higher animals with a duplex retina do possess such a mechanism, and the photomechanical responses have been discarded, except in the birds with duplex retinas where not only is the pupillary response extremely rapid but here also the photomechanical responses have been retained. Walls suggests that in birds, the rapidly mobile pupil may be more concerned with accommodation, which is so important in this group, than with changes in illumination, which indeed may still be controlled in part by the photomechanical responses. A pure-rod animal may need neither photomechanical changes nor a mobile pupil if it remains strictly nocturnal. However, such strictly nocturnal forms which seek bright light to bask must have a rapidly mobile pupil, and they actually have one (e.g., *Gecko*, snakes, chinchilla, etc.).

Another interesting deviation from the normal condition consists of a structural modification of the choroid layer in the optical axis of the eye which produces the characteristic eye-shine when light falls upon the eyes at night. Typically the heavily pigmented choroid absorbs light and prevents backward reflection upon the retina. In many forms, however, there is a region, frequently temporal to the optic disc, where the pigment is absent and where the choroidal tissue becomes arranged into a characteristic pattern of fibers or cells which reflect light back on the retina. This structure is called the tapetum lucidum. Such a mechanism presumably creates a differential illumination between any given object and the background and thus enhances discrimination between the two.

In the herbivorous animals the tapetum is composed of glistening connective tissue fibers and is

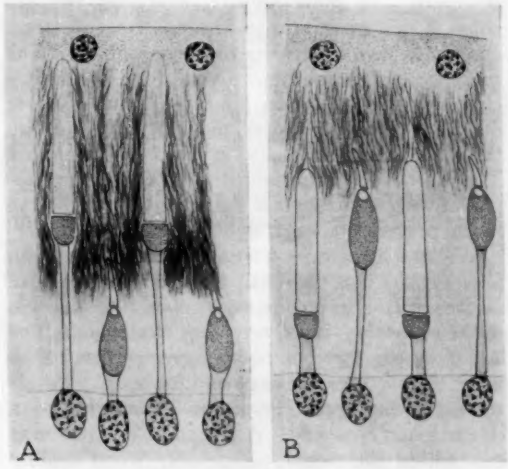


FIG. 21. Showing so-called photomechanical responses of the retina. In strong light (A) the epithelial pigment has migrated down towards the external limiting membrane (dark line), the rods have elongated and the cones have contracted. In dim light or darkness (B) the reverse movements occur, contraction of the pigment, contraction of the rods and elongation of the cones.

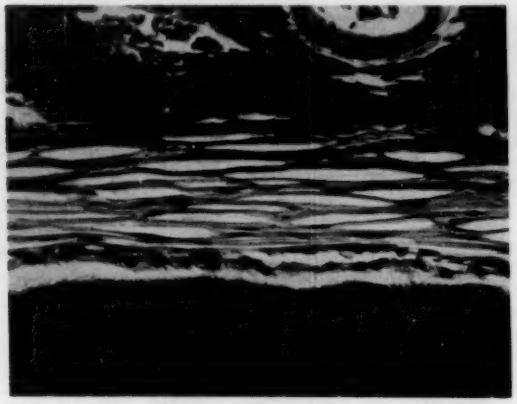


FIG. 22. Photomicrograph of the fibrous choroidal tapetum of the nocturnal lemur, *Nycticebus tardigrada*. × 300.

called the tapetum fibrosum (fig. 22). In many other forms the tapetum is composed of cells which are arranged like superimposed bricks and is called the tapetum cellulosum. It is rather characteristic of carnivors. The eye shine of the cat has been known for ages. Eye shine does not depend entirely upon a choroidal tapetum, for it is found in many animals which lack this choroidal structure. In some animals, however, the eye shine is due to certain inclusions of a substance, guanin, which occurs in the retina itself. The presence of this substance in the form of the calcium salt gives the tissue a metallic lustre of silver or gold. Guanin, however, may not be confined to the retina, for it exists also in the choroidal tapeta. The tapeta, whatever their disposition or type, apparently serve to increase the sensitivity of the eye in the presence of weak light.

We are all aware from our experience with photography that the detail which a photosensitive surface can register depends upon the fineness of the elements. If the receiving elements are fine and close together one obtains greater detail than when the particles are large and far apart. In this respect a fine grain emulsion is superior to a course grain emulsion. A comparable situation is met within the retina. Especially when dealing with cones, a low visual acuity signifies that the average distance between the retinal elements is large, whereas a high visual acuity means that the distance is small. The vertebrate eye varies greatly in this respect. Since the number of visual elements is fixed structurally in any given region of the eye, it is apparent that the number of elements per unit area must vary functionally in order to mediate the great variation in visual acuity accompanying changes in illumination. The requirements for great variations in visual acuity cannot be met entirely by the structural make-up of the retina alone, hence they must be met by differences in threshold values. Since, however, the resolving power of the retina depends also upon the average distance apart of the photosensitive elements it is apparent that vision must vary greatly in different forms.

An important feature of day-seeing eyes is the presence of a local region, highly specialized, for increasing the resolving power of the retina. This region is called the area centralis retinae. It is typically present in the fundus of the eye and in the optical axis. It is characterized by a local increase in the number of visual elements per unit area, and in most forms involves cones only. The elements become elongated and more slender, and may be so condensed as to cause an increased thickness of the external nuclear layer (nuclei of the cones) and an inward bulging of the external limiting membrane. Such a region is illustrated by the turtle eye (fig. 23). Within this area, in many forms, there is a depression or thinning of the retina called the fovea. The degree and form of this depression vary in different animals.

In diurnal birds and lizards, the fovea is deep and its slope is convex. This type is termed a convexiclivate fovea and is illustrated in figure 24. The less efficient areas possess foveas which

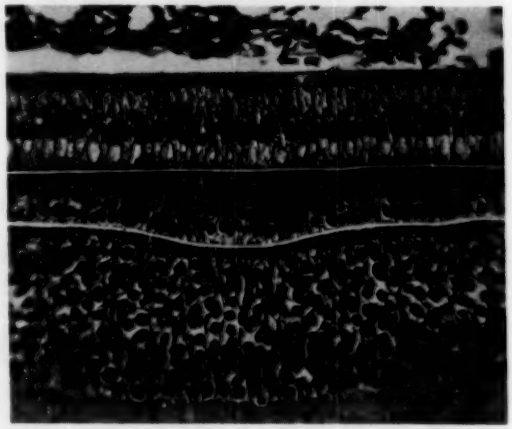
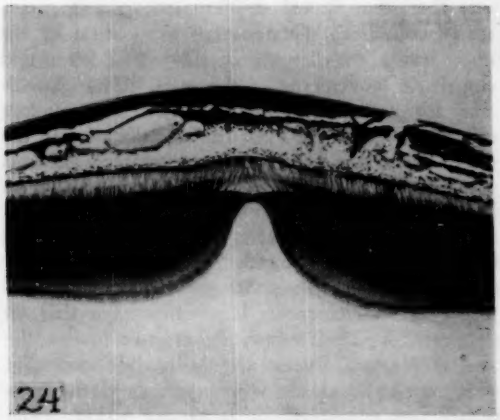


FIG. 23. Photomicrograph of the "area centralis retinae" of the turtle, showing bulging of the external nuclear layer (between lines) by reason of increased cone population per unit area. × 350.



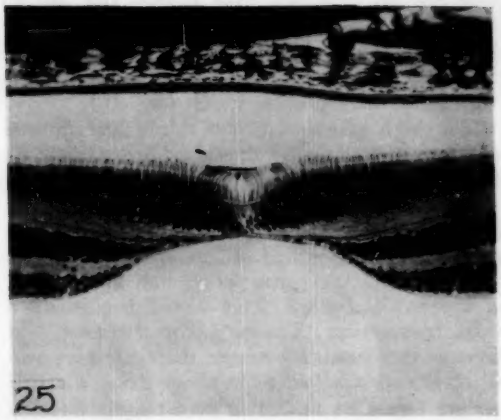


FIG. 24. Photomicrograph of the convexiclivate fovea of the Chameleon. × 50.

FIG. 25. Photomicrograph of the concaviclivate fovea of the Marmoset. × 100.

are more shallow and concave (concaviclivate). These are found in certain deep sea fishes, owls, domestic birds, anthropoids, and man (fig. 25). So deep is the convexiclivate fovea in some forms that all of the nuclear layers are displaced laterally (fig. 24). The general opinion has been prevalent that the foveal pits have been evolved so that light may have unimpeded access to the visual cells without passing through the various layers of the retina—thus enhancing high visual acuity in this region of the retina. It must be born in mind, however, that the area centralis retinae in forms without a foveal depression also serves as a region of high visual acuity. In some forms possessing an area centralis, the retina is actually thicker in this region than the less specialized retina beyond its limits; despite this the resolving power of the area centralis is greater, thus indicating that a thin spot *per se* is apparently not so important. In all animals the retina is completely clear and extinguishes no more light than the vitreous, which, in forms with a fovea, fills the foveal excavation. What then is the function of the fovea? In this connection Walls ('42) has offered a stimulating theory, based upon the difference in refractive indices of the vitreous and the retina. Valentin ('79) carefully measured the refractive index of the vitreous and the retina in a number of forms and found it to be higher in the retina than in the vitreous. Thus if a light ray strikes the vitreo-retinal border at anything but a right angle, it will undergo some refraction. Employing Valentin's figures, Walls showed that when light strikes the foveal clivus, it is refracted and thus broadens the image by bringing into play a larger number of visual cells than would otherwise be the case (fig. 26). The expansion of the image in the hawk's eye with a deep convexiclivate fovea was estimated to be of the order of 30 per cent. Walls also calls attention to the point that in the concaviclivate fovea such as possessed by anthropoids and man, where the refractive index of the clivus is not so great, there should still be an expansion of the image, but in such forms the mechanism is optically inferior to that possessed by reptiles and birds. If Walls' concept is correct, then the idea of the fovea as a region devised to admit light unimpeded to the photoreceptors must be relegated, and this localized region must be viewed as a mechanism for increasing the resolving power of the retina. It has the distinct merit of supporting the generally rec-

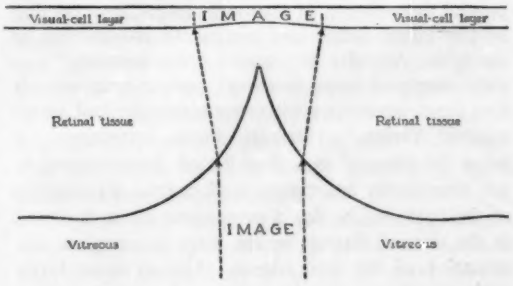


FIG. 26. The magnifying action of the foveal clivus based upon differences in the refractive indices of the vitreous and the retina according to Walls. Redrawn from Walls ('42).

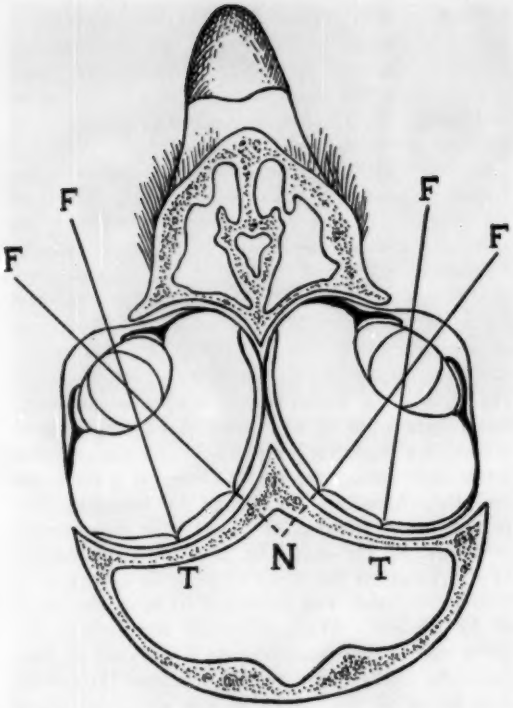


FIG. 27. Drawing showing the double fovea of the broad-winged hawk showing visual axis of temporal fovea (*F-T*) and visual axis of nasal fovea (*F-N*). Redrawn from Casey Wood ('17).

ognized fact that the foveas of reptiles and birds are more efficient mechanisms for increased visual acuity than those in anthropoids and man. Elliot-Smith ('28) assumed that true foveas are found only in anthropoids and man and emphasized that foveal development is associated with partial decussation of the optic tracts, overlapping of the visual fields and conjugate movements of the eyes. Wolff ('40) makes the statement, ". . . only man and some monkeys have a true macula and fovea centralis subserving binocular and stereoscopic vision." Despite these statements, it must be pointed out that foveal development is not necessarily associated with partial decussation of the optic tracts, for a prominent fovea is found in the diurnal lizards where there is complete decussation of the optic fibers. Also in many birds with complete optic decussation, foveas are present. Some birds, and particularly the rapacious forms, have two foveas (fig. 27). Lateral foveas are also present in salt-water fishes. It is obvious then that foveal development is not necessarily bound up with partial decussation of the optic tracts, overlapping of the visual fields and conjugate movements of the eyes. The chameleon, for example, exhibits marked independent eye movements; the eyes are laterally placed, the optic fibers are completely decussated, yet this creature has a highly developed fovea. Whereas he uses monocular vision for scanning the environment, he has the capacity of snapping his eyes forward, especially when feeding, and certainly enjoys temporary binocular vision, as well as conjugate eye movements. It would appear that, in the predatory birds which possess two foveas, the nasally located foveas are primarily concerned with monocular vision, whereas those placed temporally are employed for binocular vision. The bird eye has little movement in the orbit, but its head has a wide range of rotation on the neck. A hawk, therefore, with this ability plus a temporal fovea in each eye, can undoubtedly follow objects very well with binocular vision (fig. 28).

The high visual acuity of birds and diurnal reptiles with greatly developed convexiclivate foveas, is augmented also by the fineness of the visual elements. In the macular region of these forms the cones are very attenuated and closely packed. According to Rochen-Duvigneaud ('19) there are 1,000,000 cones per sq. mm. at the fovea of the hawk, *Buteo*. This would necessitate a solid aggregation of cones 1 μ in diameter. In humans the distance between the centers of two adjacent cones is said to be about 2.5 μ, which if correct would mean that in man the aggregation of cones would be of the order of about 160,000 per sq. mm. Based upon the fineness and average distance apart of the photosensitive elements, we would expect the visual acuity of hawks on this basis alone to be far superior to that of man, and I think experience bears this out. Even outside the fovea of this hawk, with its man-sized eye, the resolving power is said to be twice that of the human fovea, and at the fovea itself, the visual acuity of some hawks and eagles is stated to be eight times that of the human fovea.

One of the most striking structures in avian ocular morphology is the so-called pecten. This consists of a comb-like or fan-like structure projecting into the vitreous body from the optic disc. It is highly vascular and heavily pigmented (fig. 29). It has a less-developed homologue in certain diurnal reptiles, but usually in the form of a simple conical shaped projection. In the birds it reaches a striking elaboration. It is smallest in

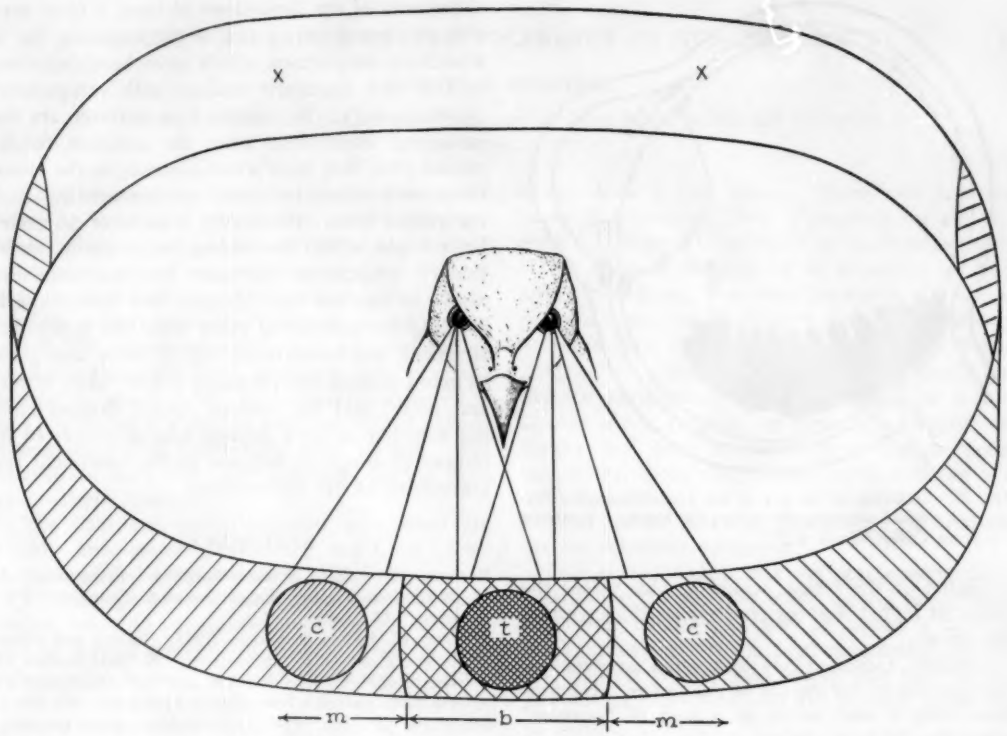


FIG. 28. Projection showing binocular field (*b*) using the temporal foveas, and the monocular field (*m*) using the nasal foveas in the bifoveate hawks. Redrawn from Walls ('42).

nocturnal birds. In the seminivorous or seed-eaters it is larger; still larger and more elaborate in insectivors, and largest in the diurnal rapacious hawks and eagles. The function of this structure has been the subject of much theory. In fact, it is said that more than thirty theories have been advanced to account for its functional significance. By many it has been regarded solely as a supplementary or accessory nutritive device for the cone-rich retina, which in birds does not have nearly so rich a choroidal blood supply as it has in mammals. It must be pointed out, however, that its position is quite far away from the retina, and nutrients and oxygen which may be given off must then diffuse for considerable distances to reach the retina which we know has a very high metabolic rate. Assuming that it may be nutritive, this still would not account for the extensive amount of pigment which characterizes this structure.

Menner placed various bird heads in a special perimeter and studied the pecten with an ophthalmoscope. He found that the pecten casts a shadow of complex shape on the retina. He felt that the shadows of the pecten pleats might serve to enhance perceptions of movements. He aimed a camera focused at infinity at circling birds in the sky. On the ground glass he could not observe them. He then constructed an artificial pecten and placed it on the inside of the ground glass. When he again aimed the camera at the circling birds, their movements were visible as images on the camera's ground glass. He thus concluded that the pecten in birds serves to enhance good visual movement perceptions.

Crozier and Wolff carried out experiments which appeared to show effects of the pecten upon the flicker fusion frequency, or in other words, the frequency at which a light may flash on and off, and still be seen as intermittent rather than as continuous light. If this be so then a man provided with an artificial pecten, with shadows optically

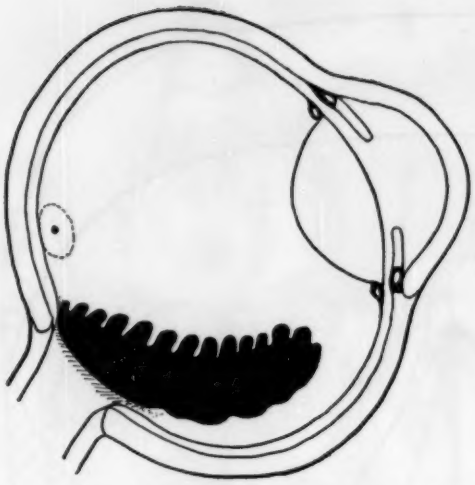


FIG. 29. Drawing of the eye of the Little Bustard (*Tetrax tetrax*) showing the pecten (in black). Redrawn from Casey Wood ('17).

projected on the retina, would be able to see the flicker at higher flashing frequencies than without this device.

Recently Griffin ('53) suggested another intriguing theory for the use of the pecten. He proposes that it may serve as a sort of "sextant" which day birds might use during migration. In this connection he points out that the sun is a useful celestial beacon for homing day birds, and that the "built-in yard stick" (pecten) would aid the bird to estimate the angular distance of the sun above the horizon. The presence of the dense pigment would serve to protect the eye against intense light, and the rich blood supply would serve to carry away excess heat from the sun's image if it should fall upon any portion of the pecten. He concludes by saying,

> Considering the extent to which the avian eye is fixed in its socket in contrast to the great freedom of rotation of the human eyeball, it is a plausible supposition that the definite outline of two pectens, plus the fixed points provided by the foveas, might provide the bird with a visual frame work of references against which the position and movements of the sun would be gauged.

As intriguing as this theory is, however, one wonders whether it has real merit, for birds migrate at night and on cloudy days when the sun cannot be used as a celestial beacon.

Because of the limitations of time, I have been able to present only a few of the imposing list of structural adaptations which have been described in the vast literature dealing with comparative ophthalmology. No matter how extreme are the structural aberrations from the common fundamental plan, they have a real meaning in the visual framework in relation to the environment in which the animal lives. Personally I know of no vertebrate organ which has undergone so many evolutionary adaptations to meet the environmental needs as has the eye. Nature has been experimenting for millions of years with this optical instrument, not constructed out of brass and glass as man's camera, but primarily out of "skin, water, and jelly," and her various optical designs cannot help but intrigue anyone who is interested in structural design in relation to the functional requirements of the environment.

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NEEDED RESEARCH ON THE TOLERANCE OF NONCONFORMITY

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(*Read April 21, 1955*)

SOME time ago the Fund for the Republic sponsored an extensive inquiry into public attitudes toward the internal Communist threat and toward reactions to this threat as they involved a disregard for civil liberties. A committee, aided by numerous expert advisers, planned a survey in which 500 interviewers from two national survey agencies discussed these problems with a cross-section of about 5,000 representative Americans in all walks of life and, in addition, with a unique special sample of 1,500 community leaders. The interviews were long and searching, lasting from one to three hours each.

The data are drawn together in a book entitled *Communism, Conformity, and Civil Liberties,* scheduled for publication this week.

I do not propose to summarize the book or to regale you with voluminous statistics which better can be studied critically in the book itself by those scholars or laymen who are interested. Rather, as a sociologist, I desire to select a few rather general propositions about the topic of tolerance of nonconformists over which I have reflected while studying our current data, and urge the importance of carrying on further researches. For no one study in social science, however searching, can be expected to do more than open a window a few inches.

By tolerance of nonconformists, of course, we do not mean approval of their views. If we are tolerant of a Socialist or an atheist or even of a Communist it does not mean that we endorse Socialism, atheism, or Communism. Rather it means that we will defend the right, within the law, for points of view of such people to be heard, discussed, and debated, and for the legal privileges of such people as guaranteed in the Bill of Rights to be safeguarded.

It is not always easy to take the sober second thought about respecting the rights of those of whom we disapprove.

But some people are more likely than others to take this sober second thought. The study just completed sought to find out what kind of people would draw a line where. Everybody has his limits of tolerance. Few, if anybody, would tolerate an admitted Communist in sensitive portions of our defense program or as a teacher in high school or college. But there are many who would purge a Communist's books from a public library or refuse him the right to speak in their town. And not only that. A large number would apply the same sanctions to a Socialist or a free thinker about religion, or even to a man whose loyalty had been criticized by a Congressional committee, though he denied under oath he was a Communist.

Who are the relatively tolerant people and who are the relatively intolerant?

Our survey shows that the people more likely than others to take the sober second thought are the better educated people, including, it may be noted, a majority of the local community leaders; the younger people; and people who live in cities in contrast with those who live in small towns and on farms.

These empirical findings, which have been documented with many charts and tables, may take on a broader significance if we try to see them in the light of two great social forces in American life. One such force is described by sociologists by the concept of "vertical mobility"; the other by the concept of "horizontal mobility."

When we speak of vertical mobility we mean the process by which people born into homes of relatively low social economic status climb the ladder of achievement during their own lifetime. This has been possible in America to a degree not equalled elsewhere because our dominant value system has coincided with an expanding frontier of opportunity. Once this expanding frontier was geographical; today it is technological. Miracles of technology and economic organization are creating, directly and indirectly, millions of new jobs of a technical, managerial, and clerical nature—white collar jobs for women as well as men —and the main gateway to these jobs is education.

Keeping pace has been the most spectacular

progress in the education of the masses in all history. It can be illustrated from one of several pieces of evidence in our recent study. Of people over sixty in our representative national cross-section, less than one in four had graduated from high school. Of adults under thirty, two out of three had graduated from high school. The proportion of these younger people with college education is double that of their elders of sixty and over; the proportion of younger people with only a grade school education is but a fifth of that among their elders.

And the trend is continuing.

Now there are at least two theoretical expectations which would predict that America's unprecedented social mobility would produce an increase in *in*tolerance.

One is in terms of an increase in personal frustration. In a highly mobile society with a high level of aspiration on the part of so many people, there will be many who do not achieve goals which they set too high. The higher the level of aspiration, the larger the discrepancy between aspiration and achievement may become. Though one's success may be great by the absolute standards of the whole world, a person may have greater anxiety about failure relative to others than he would if he lived in a more static and less striving society. The principle here involved has been given the name of "relative deprivation."

If vertical mobility in America breeds relative deprivation in the sense described, the anxiety and frustration generated in the breasts of the relatively unsuccessful should produce a heavy load of aggression which such people would need to discharge on others. They cannot always discharge it on realistic targets; these must be "safe" targets; today there is no safer target than the American Communists or those who have been defined by demagogues as near equivalents. Hence, if we look for the people who are most intolerant of nonconformists, perhaps we should look in particular for people who have aspired but have been frustrated in their effort to realize the American dream.

There is a second reason, in addition to the operation of the principle of relative deprivation, which might lead us to expect vertical mobility in America to be a bad sign for tolerance.

This lies in the fact that the mobile person may have experienced two conflicting systems of values. One is the set of values learned in his childhood, in his home or neighborhood, and one is the values of the wider world imposed on him by school and college. Obviously, some strains are involved where a simple childhood picture of life in term of truth and falsehood, good and bad, reinforced by the sanctions of an infallible church or an infallible Bible, gets replaced in school or college by the tentatives of science and philosophy. Some people can handle such strain less easily than others, and the anxieties and frustrations thus produced can generate the same effects which psychological theories lead us to attribute to relative deprivation.

On two counts, then, of relative deprivation and conflict of values, we may be led to anticipate that vertical mobility as in the United States today can generate anxieties and frustrations which make people psychologically ripe for intolerance toward objects against whom it is relatively safe to have aggressive attitudes.

And there is another great social force in American life which can reinforce what we have just said—particularly with respect to the conflict of values. That factor is what sociologists call "horizontal mobility."

People in America are moving around increasingly. Fewer and fewer people, and those predominantly in the rural areas, live in the neighborhoods in which they grew up in childhood. Fast changing technology, including the inventions of communication and transportation, has accelerated "horizontal mobility." And the movement is mostly in one direction—from the farm and small towns to the cities and city suburbs. The transition from rural folkways to urban folkways involves breaks in custom and values which can be productive of psychological strain. Hence horizontal mobility, like vertical mobility, by setting the stage for increased anxiety, can result in projections of that anxiety on others and an increased tendency toward intolerance of people whom it is safe to dislike.

That the mechanisms of anxiety and scapegoating which we have postulated do exist has been quite clearly established in clinical psychological studies. However, it is not too easy to establish directly the operation of these mechanisms either in experimental studies or in surveys like the study upon which we are reporting. At the conscious level, our study showed most of the population to be surprisingly optimistic about their personal future. Two thirds of the people said they expected life to be better for themselves in the future than in the past and only one person in seven thought life would be worse. However, the latter tended to be predominately people in their

sixties, seventies, and over, some of whom were worried about failing health or lack of security. The general climate of optimism to-day perhaps should not be too much of a surprise, considering the level of employment and real wages in the country or considering indirect evidence of optimism which is indexed by the sustained high birth rate. People who, though possessing today knowledge of contraception, are having larger and larger families, are not behaving as anxiety ridden individuals. Nor has fear of atomic extinction taken possession of the public. In the first half hour or so of our interviews, we sought to probe, with as skilful non-directive techniques as we knew how to employ, for anxieties about war and the atom bomb, and found few, indeed, who appear to be worrying about impending doom. Of course, the worries may be deep but suppressed, yet most of the evidence marshalled in this study is against such a likelihood, rather than in favor of it.

We do find, however, that the more optimistic people also tend to be more tolerant toward nonconformists like Socialists, atheists, or admitted Communists or toward suspected Communists. This may, indeed, account in part for our finding that people over sixty are more intolerant than younger people, for the finding as to age holds at every educational level.

But before we press the frustration-aggression hypothesis too far, let us consider some other facts.

First, may I give an impressionistic report? If you could sit down as I did and read the entire questionnaires of the most intolerant people in our study, containing masses of free comments taken down as nearly verbatim as possible, you might wonder whether another explanation of much of the intolerance were not even more plausible. Most of these people seemed to be good, wholesome Amreicans, who were drawing logical inferences from incorrect premises. Consider, for instance, an ardent Protestant fundamentalist or Catholic who has been told that free thinkers about religion are Communists or Communist dupes. If he believes—as is probably true—that secular colleges do weaken some religious certainties of students, it is not illogical for him to be as intolerant of the concept free thinker as of the concept Communist and put them in the same box. One hardly needs to postulate deep personal anxiety to account for this kind of anti-intellectualism.

And, indeed, most of the statistical data in our study, in my judgment, are not inconsistent with a rather simple cognitive level of explanation of the relationship between tolerance and vertical and horizontal mobility.

What does tolerance require, at the cognitive level? The first step in learning tolerance would seem to be learning that other people can have values different from mine and that which is different is not necessarily bad. Or, even if I don't like such people, I can live and let live. This may be only the first lesson, since a further requirement is to learn that it is a positive good for America to maintain a free market place of ideas, however unconventional and unpopular those ideas may be.

Now how do the social forces of vertical and horizontal mobility operate with respect to teaching at least the first of these lessons? Both would seem to favor it. Education, the main mechanism today of vertical mobility, is a process of exposure of youth to new and competing ideas. The higher one goes up the educational ladder the more likely he is to encounter the unfamiliar and to learn how to cope with it. Of course this encounter can produce its Sturm and Drang, but the encounter is made and without it tolerance might be less likely. Likewise, the person who lives all his life in the same rural community where he grew up is much less likely to encounter in his personal contacts people with values different from his own than is the person who migrates to the city. Again, as we have pointed out, strain can be produced among the latter, but there is something in city life which teaches that people can be different from me and not necessarily bad, or that, even if I dislike them, I can live and let live. In the office, in the labor union, in the city neighborhood, as well as in the general anonymity of more casual contacts, these lessons can be learned.

The empirical data in our study give strong support to such an interpretation. Tolerance is highest among college graduates in metropolitan cities. It is lowest among grade school people on the farms. In each type of community in every region taken separately it increases with education. For example, take Middle Western metropolitan cities. On a 15-item scale of tolerance of nonconformists, the percentages classed as "relatively more tolerant" vary as follows:

College graduates	64%
Some college	59%
High School graduates	42%
Some High School	31%
Grade School	18%

The same pattern, though with different absolute level of percentages, holds in all other types of communities and all other regions. Or look at people at the same educational level, when compared by type of community. Take for example people in the Middle West who have finished grade school but not high school. Percentages classed as more tolerant on our scale are, by place of residence:

Metropolitan areas	31%
Other cities	23%
Small towns	17%
Farm	13%

Such data argue strongly for the proposition that education and city life each operate in the direction of tolerance, in spite of whatever strains which they may generate.

With respect to education, there are two further points to be made. First, as part of the process of learning that the different is not necessarily bad, one has to learn to make discriminations—for example, between the Communist and the free-thinker, or between the risk of a Communist in a sensitive defense job and the risk of a Socialist making a speech in one's community. The better educated tend to make such discriminations; the less educated less so. We tapped the variable of "rigidity of categorization" by asking whether respondents agreed or disagreed with the statement, "People can be divided into two classes —the weak and the strong." The pattern of responses by education closely paralleled the pattern of responses to our scale of tolerance of nonconformists.

Second, there is evidence that the better educated people are less authoritarian in attitudes and more likely to favor independence training in child-rearing practices. For example, the patterns of responses by education closely paralleled the responses to the tolerance scale when we examined agreements and disagreements to the following two statements:

A child should never be allowed to talk back to his parents, or else he will lose respect for them.

If a child is unusual in any way, his parents should get him to be more like other children.

When we see, in addition, that it is not only the better educated, but also the younger among the better educated who are most likely to favor non-authoritarian and independence training, we may have a clue which will warn us not to assume that intolerance is a function of aging alone. The present younger generation is a product of a school system which has been influenced to varying degrees by the independence training of progressive education. Likewise, the younger people of today are the products of far more permissive child-rearing practices in the home than are their elders. "Life with Father" may be a caricature, but if it ever existed it probably is gone forever.

These forces in education, namely greater independence training in child-rearing and in the school, may indeed be working in such a way that the young person of thirty, even if he has no more formal education than his parents, may be more tolerant when he is sixty than his parents were at sixty, everything else being equal. And since, as is indisputable, the majority of our younger people are actually getting far more years of schooling than their parents, the outlook should be anything but dismal.

To sum up at this point. On the one hand, I have suggested how conceivably vertical and horizontal mobility in America could generate strains and anxieties which could lead to intolerance, through the mechanisms of relative deprivation and conflict of values as they lead to projection of aggressions on others. On the other hand, I have suggested how vertical and horizontal mobility could teach lessons which are a necessary condition to tolerance by bringing one into contact with people and values different from one's own and paving the way for ultimate appreciation of the positive virtues of a free market place of ideas. As I read the evidence from our study, both sets of forces may be operating, but the latter seem to me far to outweigh the former. In other words, vertical and horizontal mobility on balance seem to promote tolerance of nonconformity in spite of strains which may be generated in an opposite direction.

It may be objected that in the years since the War intolerance has risen at the same time as mobility has gone on apace. Granted. But never since the Copperhead conspiracy has there been such a provocation for the suspension of civil liberties. It takes time for the sober second thought of the nation to be mobilized in the face of such provocation. For a period a very small group of demagogues seemed to hold the stage with hardly a challenge. But there are many intimations that the rising tide of intolerance since the War is not a long-term trend, but rather a cyclical fluctuation around a trend. And the trend may be responsive to great social forces making

in the long run for greater tolerance, unless new external provocations press too heavily against it.

Now I have entitled this paper "Needed Research on the Tolerance of Nonconformity." I did so with deliberation, although I cannot take the time to outline in detail the kinds of further research that are needed. I choose this title to emphasize the lack of knowledge, in contrast with the extent of knowledge.

While the current book on *Communism, Conformity, and Civil Liberties* has added some new facts to our body of knowledge and has proposed some new ways of conceptualizing the problems, it has not produced definitive answers. Its most important contribution, if any, should be in the stimulation of further inquiry.

Fortunately, psychology and the social sciences have come sufficiently of age so that inquiry need not be limited to essays in the armchair or unsystematic clinical observations, however useful they may be. The psychological mechanisms we have postulated are capable of experimental study, with explicit tests in laboratory situations. Such investigations have been going on, in ever increasing number, and they need to be further accelerated. Sociologists and anthropologists, through field surveys, with better and better instruments for measuring the crucial responses, are demonstrating that even such difficult and elusive subjects as social values can be studied with some objectivity and precision, and that there are very significant relationships between what people say and what they do, even though by no means a perfect correlation. And we know how to draw good probability samples, thanks to the mathematical statisticians, and how to make appropriate tests of significance.

The most crucial studies in the future may not be the big ones. They may be small intensive inquiries designed to test narrow restricted hypotheses. And some of the most relevant of these hypotheses may seem at the moment far removed from the burning issues of the day. (If any foundation executives happen to be around, I hope they have listened with special attentiveness to this last sentence.)

The maps we have now, including the one I have sought to draw for you today, are as crude as the maps of the Western world in the early sixteenth century. But galleons are sailing the Spanish main and, if more and more can be despatched, we shall fill the gaps in our knowledge.

If, in turn, such knowledge can help ever so little in the preservation of the ideals of freedom enshrined here in Independence Square, the effort will not have been in vain.

POLITICAL MOBS AND THE AMERICAN REVOLUTION, 1765–1776

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(*Read April 21, 1955*)

MASS violence played a dominant role at every significant turning point of the events leading up to the War for Independence. Mobs terrified the stamp agents into resigning and forced a repeal of the tax. Mobs obstructed the execution of the Townshend Revenue Act and backed up the boycotts of British trade. Mobs triggered the Boston Massacre and later the famous Tea Party. The last disturbance, however, goaded the long-suffering Parliament to harsh retaliation, and this legislation, known ever since as the Intolerable Acts, provoked the colonists first to armed resistance and then to revolution. But even at this climactic stage of the controversy civilian mobs behind the lines systematically intimidated Tory opponents, paralyzing their efforts or driving them into exile.

This quick résumé presents a bald contrast to the traditional picture of a dignified movement of protest stemming from lofty constitutional principles and directed by men of the signal stature of James Otis, John Adams, John Dickinson, and Thomas Jefferson.[1] The point, of course, is that the patriot movement comprised diverse elements and motives, and that a posterity, grateful for the end result, has preferred to remember only the more genteel aspects. Suffice it to say, however, that a Tory commentator on the eve of the final break with England spoke out of fullness of knowledge when he asserted that "mobs were a necessary ingredient" in the mode of opposition.[2]

I

These outbreaks consisted of two general kinds: those deliberately engineered in advance by the Whig leaders and those that were spontaneous explosions. But, whatever their origin, they furthered patriot purposes in several essential ways. They highlighted grievances as mere words could never have done; they struck terror into the hearts of British adherents; and, as notably in the case of the Boston Massacre, they fashioned folk heroes out of street loafers and hoodlums.

Three examples will illustrate the calculated use of violence. The first consisted of the mobs throughout the continent which in 1765 ousted the stamp distributors before the Stamp Act had time to go into effect. What General Gage remarked of the situation in New York held equally true of all the other colonies. "The Plan of the People of Property," he informed the Ministry, "has been to raise the lower Class to prevent the Execution of the Law," and he opined that many of the instigators had themselves shared in the riots.[3] In Boston the Whig politicians took little pains to conceal their participation, for some forty substantial citizens, thinly disguised in the trousers and jackets of mechanics, headed the marchers who wrecked the stampmaster's abode.[4] Lieutenant Governor Thomas Hutchinson, one of the victims of the attendant commotions, has described the local chain of command. The "rabble," he said, took their cue from "a superior set consisting of master-masons, carpenters, &c.," who in turn took theirs from a merchants' committee in certain matters and from the "mob-high eloquence" of the town meeting in still others.[5] If this evidence be regarded as prejudiced, John Adams's diary supplies ample corroboration.

[1] For an historiographical explanation of this attitude, see Fisher, S. G., The legendary and myth-making process in histories of the American Revolution, *Proc. Amer. Philos. Soc.* **51**: 53–76, 1912. As Fisher remarks in conclusion, "The real Revolution is more useful and interesting than the make believe one."

[2] "Massachusettensis" (Daniel Leonard) in the *Massachusetts Gazette and Boston Post-Boy*, December 19, 1774.

[3] Letter to H. S. Conway, December 21, 1765, Gage, Thomas, *Correspondence with the secretaries of state* **1**: 78, Carter, C. E., ed., New Haven, Yale Univ. Press, 1931. For the situation generally in the colonies in this respect, see Gordon, William, *The history of the rise, progress, and establishment of the independence of the United States* **1**: 199, London, Dilley and Buckland, 1788, and Morgan, E. S. and Helen M., *The Stamp Act crisis*, 180–187, Chapel Hill, Univ. of North Carolina Press, 1953.

[4] Hutchinson, Thomas, *The history of the province of Massachusetts Bay* **3**: 120–121, London, J. Murray, 1828.

[5] Hosmer, J. K., *The life of Thomas Hutchinson*, 103–104, Boston, Houghton, Mifflin, 1896.

A second outstanding example of premeditated lawlessness was the burning of the British revenue schooner *Gaspee* near Providence, Rhode Island, at midnight of June 9, 1772. John Brown, one of the town's leading merchants, not only organized the destruction ahead of time but personally took part in it.[6] But the most notable instance was the Boston Tea Party late in the following year.[7]

Over a space of six weeks before the event, the town meeting and various unofficial gatherings, augmented by people from neighboring communities, had protested the importation of dutied tea by the monopolistic East India Company. When in due course the vessels arrived and the Crown authorities refused to allow them to depart without payment of the hated tax, Samuel Adams, jumping to his feet in the densely packed Old South Church, gave the prearranged signal: "This meeting can do nothing more to save the country." At once a war whoop at the door started a lurking band of make-believe Mohawk Indians to Griffin's Wharf, where they cast the 342 chests into the harbor. A crowd on shore looked silently on. History has never beheld a more superbly disciplined mob. Despite the intense excitement the vandals hurt no person aboard and were so respectful of private property that they even replaced a broken padlock.[8]

II

By contrast were the countless self-willed mobs. A notorious early instance was the pillaging of Lieutenant Governor Hutchinson's mansion in Boston in August, 1765, during the Stamp Act disorders. Not content with gutting the structure from ground to roof, the "hellish crew" scattered abroad Hutchinson's historical papers and the manuscript of the second volume of his *History of Massachusetts Bay*.[9] Even more alarming was the so-called Battle of Golden Hill in New York in January, 1770. This was the climax of a long series of street brawls between the populace and the redcoats that had been going on ever since the troops were stationed there for purposes of imperial defense at the close of the French and Indian War. In this culminating affair the soldiers fought back with bayonets and cutlasses, killing one of the crowd and wounding others.[10]

But the pre-eminent affray with the military was the set-to on King Street in Boston some weeks later. A British garrison had been sent to the Massachusetts capital two years before following a particularly daring riot over the customhouse seizure of John Hancock's sloop *Liberty* for alleged smuggling. Bad blood had quickly developed between the soldiers and "the inhabitants of the lower class," who openly insulted the intruders, beat them up in dark streets and haled them into court on every possible excuse.[11] Popular resentment mounted dangerously when a customs informer accidentally killed a boy while firing into a threatening mob. When the funeral was held, a great throng ostentatiously escorted the remains to the cemetery in imitation of a recent turnout in London for a child murdered during a riot in St. George's Field. The demonstration was, as Hutchinson bitterly remarked, designed further "to raise the passions of the people."[12]

Soon afterward, on the night of March 5, 1770, a file of regulars, provoked beyond endurance, shot into a crowd of their tormentors, slaying five and injuring others. The tragedy was purely an affair of the moment, but the Whig chieftains, quick-wittedly capitalizing on the propaganda possibilities, at once labeled it the "Boston Massacre" and acclaimed the fallen—whose very names were unfamiliar to most of the townsfolk—as martyrs to the cause of American liberty. Not all the patriots, however, agreed. Two of the most respected, indeed, John Adams and Josiah Quincy, Jr., acted as legal counsel for the soldiers at their trial and secured their acquittal of the

[6] Bartlett, J. R., *A history of the destruction of His Britannic Majesty's schooner Gaspee*, 17, 19, 23, Providence, A. C. Greene, 1861; Hedges, J. B., *The Browns of Providence Plantations: colonial years*, 209–210, Cambridge, Harvard Univ. Press, 1952.

[7] Schlesinger, A. M., *The colonial merchants and the American Revolution*, 281–290, New York, Columbia Univ. Press, 1918; Bancroft, George, *History of the United States* **6**: 472–478, Boston, Little, Brown, 1854; Channing, Edward, and A. C. Coolidge, eds., *Barrington-Bernard correspondence*, 294–302, Cambridge, Harvard Univ. Press, 1912.

[8] Drake, F. S., ed., *Tea leaves*, pp. lxv, lxviii, Boston, A. O. Crane, 1884.

[9] Hutchinson to Richard Jackson, August 30, 1765, *Publ. Colon. Soc. of Mass.* **26**: 33, 1924–1926. Hosmer, *Hutchinson*, 351–362, gives a detailed inventory of the losses.

[10] Dawson, H. B., *The Sons of Liberty in New York*, 112–118, New York, Platt & Schram, 1859.

[11] The quoted phrase is John Adams's in his *Works* **2**: 230, Adams, C. F., ed., Boston, Little, Brown, 1850.

[12] Hutchinson, *Massachusetts Bay* **3**: 269–270.

charge of murder. It is also significant of the sober second thought of the inhabitants in general that in the midst of the furor they elected Adams for the first time to the legislature.[13]

III

Political mobs, though long prevalent in England and never more rampageous than during the 1760's, had hitherto been rare or unknown in America.[14] The absence of deep-seated and irremediable class divisions plus the eagerness of the colonial legislatures to espouse popular rights probably account for the difference. But now, with the issues involving a distant and uncontrollable Parliament, mobs roared into action on the slightest pretext all the way from New Hampshire to Georgia. Though the coastal cities set the pace, inland towns and villages were seldom far behind.

The Crown officials stood well-nigh helpless before the anarchy. The colonial law-enforcement agencies usually winked at the outbreaks, and if the culprits were brought into court, the juries quickly cleared them. This is not surprising, because sometimes both the magistrates and individual jurors had themselves joined in the disturbances and, in any event, they did not dare risk the consequences of defying community sentiment; in New England indeed the town meetings actually elected the jurors. General Gage reported from New York that "the Officers of the Crown grow more timid, and more fearfull of doing their Duty every Day." And in similar strain Governor Hutchinson declared of his plight during the opposition to the East India Company shipments, "There was not a justice of peace, sheriff, constable, or peace officer in the province, who would venture to take cognizance of any breach of law, against the general bent of the people." [15]

Behind this "bent of the people" lay the fact that the masses perceived nothing morally wrong in nullifying attempts to enforce legislation which they considered oppressive and to which they had never consented. Few Americans could accept the British view that the tumults were criminal proceedings, and those who did so ordinarily kept silent out of a prudential regard for their own persons and property. There was, to be sure, though mainly outside Massachusetts, a strong vocal reaction to the Boston Tea Party, as an uncalled-for deed of destruction, but this vanished when Parliament overreached itself by passing the Intolerable Acts.[16]

It is also to be noted that a singular self-restraint characterized the frenzies, for the participants invariably stopped short of inflicting death. They trusted to horror rather than to homicide. Though occasionally brandishing cutlasses and muskets, they typically employed less lethal weapons like clubs, rocks, brickbats, and clods of dung. "In truth," wrote the English historian, Lecky, in the 1880's, generalizing upon this curious phenomenon, "although no people have indulged more largely than the Americans in violent, reckless, and unscrupulous language, no people have at every period been more signally free from the thirst for blood, which in moments of great political excitement has been often shown both in England and France." [17] This forbearance doubtless made it easier for the more law-abiding Whigs

[13] Adams, *Works* **2**: 230–236. The essential documents for the whole episode may be found in Kidder, Frederic, ed., *History of the Boston Massacre,* Albany, J. Munsell, 1870.

[14] Benjamin Franklin wrote from London in 1768, "I have seen within a year riots in the country about corn; riots about elections; riots about work-houses; riots of colliers; riots of weavers; riots of coal-heavers; riots of sawyers; riots of Wilkesites; riots of government chairmen; riots of smugglers; in which custom-house officers and excisemen have been murdered, and the King's armed vessels and troops fired at." Wells, W. V., *The life and public services of Samuel Adams* **1**: 228–229 *n.*, Boston, Little, Brown, 1865. For a historical account of this aspect of the 1760's, see Lecky, W. E. H., *A history of England in the eighteenth century* **3**: 98–99, 143–148, 163–164, New York, Appleton, 1882, and, for an earlier period, Beloff, Max, *Public order and popular disturbances, 1660–1714,* chap. 2, London, Oxford Univ. Press, 1938.

[15] Letter to Lord Barrington, July 22, 1769, Gage, *Correspondence* **2**: 518, 1933; Hutchinson, *Massachusetts Bay* **3**: 437.

[16] Schlesinger, *Colonial merchants and the American Revolution,* 298–300, 304, 309–311. Even within Massachusetts the town meeting of Freetown shortly after the drowning of the tea denounced the "Spirit of Anarchy, Disorder and Confusion prevailing in some Parts of this Province" and bade its member of the Assembly to put an end to "all such riotous and mobish Proceedings." *Boston Evening-Post,* February 7, 1774.

[17] Lecky, *England in the eighteenth century* **3**: 401. William Gordon in his *Rise, progress, and establishment of the independence of the United States* **1**: 321, published a few years after the war, states that, "in all my researches, not an instance has occurred to me of the mob's having been the death of a single individual." "Novanglus" (John Adams) in the *Boston Gazette,* February 13, 1775, and "Lucius" in the *Massachusetts Spy,* March 9 of the same year, earlier boasted of this record. There were, however, some near-fatalities, notably the shooting of a soldier in the sequence of incidents eventuating in the Boston Massacre, and the wounding of the commander of the *Gaspee,*

to condone the outbreaks but it afforded cold comfort to the victims, who never knew when a mob, fortified perhaps with alcoholic as well as patriotic spirits, might overstep the bounds.

Still the greater opprobrium, that of actually taking lives, fell alone on the "British tyrants" and their hirelings. Considering the repeated provocations the wonder is that they did not do so more often, but this fact naturally failed to impress the colonists. The Massachusetts patriots, taking political advantage of the most fatal of these incidents, annually commemorated the Boston Massacre with awesome ceremonies. On each anniversary the bells of the town tolled at intervals during the day, and at night lighted transparencies near the site of the bloodshed displayed tableaux of the "murderers" and the dead, with perhaps a symbolic America trampling a supine redcoat under foot. Sometimes an exhortation in verse pointed up the moral, such as the screed beginning:

> Canst thou, Spectator, view this crimson'd Scene,
> And not reflect what these sad Portraits mean?
> Or can thy slaughter'd Brethren's guiltless Gore,
> Revenge, from Year to Year, in vain implore?[18]

The crowning event was the declamation by a well-known figure, who pulled out all the stops to do full justice to his theme. To quote one of the orators,

> . . . words can poorly paint the horrid scene—defenceless, prostrate bleeding countrymen—the piercing agonizing groans—the mingled moan of weeping relatives and friends—these best can speak, to rouse the luke-warm into noble zeal; to fire the zealous into manly rage, against the foul oppression of quartering troops, in populous cities, in times of peace.[19]

These addresses, besides electrifying those within earshot, reached a far larger public in printed form and, as John Adams tells us, they "were read, I had almost said by every-body that can read, and scarcely ever with dry eyes."[20] The yearly orations continued—though necessarily outside Boston while the British held hostile possession—until the town authorities in 1783 substituted the celebration of the Fourth of July.

While the rioters avoided fatalities, they had no compunctions about wantonly destroying property, mauling the unfortunates, tar-and-feathering them and lynching them in effigy. The tar brush was the favorite discipline for those of low degree. The mob after applying a "suit of the modern mode" carted the victim through the town as an object lesson to others as well as himself.[21] Squire M'Fingal's ordeal in John Trumbull's mock epic of a Massachusetts Tory hardly exaggerates genuine occurrences.[22] In one affair the vigilantes even set fire to the feathers.[23]

Hanging in effigy was reserved for offenders of higher station. Even though this form of retribution did not harm the flesh, it was probably no easier on the spirit. Royal governors, stampmasters, revenue collectors, contumacious importers, tea consignees and the like suffered this indignity, sometimes in company with their official superiors in London—Lord Bute, George Grenville, Lord North, and so on—or with their alleged infernal chief, the devil. After the passage of the act in 1774 legally establishing Roman Catholicism in the province of Quebec, the Pope sometimes joined the cast of characters, thus symbolizing the people's religious as well as political bias. Indeed, the overzealous townsfolk of Newport, Rhode Island, on one occasion displayed two Popes.[24] The accepted ritual was to exhibit the grotesque figures for some hours, then carry them through the streets to the gallows or to a funeral pyre. As in the case of tar-and-feathering, the proceedings, whether or not intimidating the persons intended, vividly advertised the enormity of their misconduct to the public.

IV

The representatives of the Crown continually sent home pathetic accounts of their helplessness in the face of these excesses, but the London authorities were too far away and too preoccupied with their own pressing affairs to give the matter

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[18] *Boston Gazette*, March 8, 1773.

[19] Dr. Benjamin Church in 1773, Niles, Hezekiah, ed., *Principles and acts of the American Revolution*, 37, rev. ed., New York, Barnes, 1876, in which work can be found the texts of all the orations, on pp. 17–79.

[20] Letter to Jedidiah Morse, January 5, 1816, Adams, *Works* **10**: 203, 1856.

[21] The quoted expression is from the *Boston Evening-Post*, June 25, 1770, and the *New-Hampshire Gazette*, January 20, 1775. In a similar facetious spirit a group at Falmouth, Casco Bay, announced the appointment of a "Committee for Tarring and Feathering" consisting of "Thomas Tarbucket, Peter Pitch, Abraham Wildfowl, David Plaister, Benjamin Brush, Oliver Scarecrow and Henry Hand-Cart." *Massachusetts Spy*, February 24, 1774.

[22] *M'Fingal* (many editions), Canto Third.

[23] Jones, E. A., *The Loyalists of Massachusetts*, 243, London, Saint Catherine Press, 1930.

[24] *Newport Mercury*, November 7, 1774.

systematic attention. Francis Bernard, Hutchinson's predecessor as Governor of Massachusetts, complained that "the indifference which has been shown in England to the checking the Demagogues of America for so long a Time has at length so effectually discouraged the Friends of Government, that they have been gradually falling off, 'till at length the Cause is become desperate."[25]

Yet even when the imperial government sought to lend a hand, as it did from time to time, the results were invariably disappointing. Upon the repeal of the Stamp Act the Ministry, at the behest of the House of Commons, instructed the colonial governors to require the legislative assemblies to indemnify all persons who had lost property in the disorders; but only three provinces responded. Of these, Maryland alone voted full damages; New York recompensed one of the two major sufferers but not the other; and Massachusetts after stalling for fifteen months reimbursed Hutchinson for his looted mansion, but only on condition of a general amnesty for all mob participants throughout the province during the troubles.[26]

Three years later, in 1769, the government moved to prevent the thwarting of justice by biased juries in the prosecution of rioters. With this object chiefly in mind Parliament proposed that colonists charged with treasonable behavior be conveyed to England for trial under an old statute of Henry VIII;[27] and in retribution for the *Gaspee* destruction in Rhode Island in 1772, the Ministry set up a royal commission to do just that. Though the tribunal conducted its inquiry on the spot and fully a thousand people must have known the perpetrators, it could not obtain sufficient evidence to apprehend a single suspect.[28] The proceeding only resulted in sending a flame of indignation through the colonies.

Nor did the presence of British troops in New York and Boston, the major storm centers, have the desired effect. On the contrary, the enforced association, irksome to both parties, merely intensified the friction that normally exists between garrisons and the civilian population. To the townsfolk the "Bloody Backs" were visible reminders of "English tyranny," hence proper objects of verbal and physical harassment; and not unnaturally the soldiers returned these attentions in kind. The Battle of Golden Hill and the Boston Massacre were merely extreme examples of the explosive outcome.

It was a preconcerted riot, however, not a spontaneous disturbance, that finally drove Britain to drastic punitive action. The Intolerable Acts, passed in retaliation for the Boston Tea Party, permanently deprived the entire province of cherished democratic privileges and closed the port of Boston to seaborne commerce until the East India Company should be reimbursed and the King be otherwise convinced that the Bostonians henceforth would be law-abiding. Parliament further took away from the Whig-controlled town meetings the right of choosing juries and gave it to the sheriffs, who were creatures of the Crown-appointed Governor; and, to make assurance doubly sure, it provided that anyone accused of murder while quelling an outbreak might be tried in another colony or in England.[29]

This stringent legislation, precipitated by a particular act of mobbing, dealt with conditions that had actually been long out of hand. But, however warranted the measures appeared from the meridian of London, they outraged the colonists' sense of fair dealing by ignoring the distinction between innocent and guilty and indicting a whole people for the sins of a few. Parliament thereby exercised an authority far more ominous to popular liberties than taxation without representation or invidious trade regulations.

Had the Americans through the years pursued only lawful methods of opposition, the crisis could not have arisen, and the mother country would have avoided this naked display of power. Now, even though Massachusetts was the one province struck at, the Ministry flung down a challenge which the other colonies dared not ignore, since

[25] Letter to Lord Barrington, July 30, 1768, *Barrington-Bernard correspondence*, 170.

[26] *Annual Register for the Year 1766*, 46, London, 1767; Horatio Sharpe to Hugh Hamersley, December 8, 1766, Sharpe, *Correspondence* **3**, 358, Browne, W. H., ed., *Archives of Maryland* **14**, Baltimore, 1895; Keys, Alice M., *Cadwallader Colden*, 330–331, New York, Columbia Univ. Press, 1906; Brown, E. F., *Joseph Hawley*, 107–110, New York, Columbia Univ. Press, 1933; Gipson, L. H., *The coming of the Revolution*, 165–169, New York, Harper, 1954. The Privy Council disallowed the Massachusetts enactment because of the rider, but not in time to stop the payment of £ 3194 from being made.

[27] Gipson, *Coming of Revolution*, 192–193.

[28] Wulsin, Eugene, The political consequences of the burning of the Gaspee, *R. I. History* **3**: 1–11, 55–64, 1944; Leslie, W. R., The Gaspee affair: a study of its constitutional significance, *Miss. Valley Hist. Rev.* **39**: 233-256, 1952–1953; Bartlett, *Destruction of His Britannic Majesty's schooner Gaspee*, 55–140.

[29] 14 George III, c. 19, c. 39, c. 45.

none knew when its own turn might come. Within a few months the First Continental Congress assembled, and a train of events began which led to Lexington and Concord and onward to independence.

V

When the troubles began some ten years before, no one could have foreseen this outcome, and few if any would have desired it. Virtually everyone believed that the difficulties could be and should be adjusted within the framework of the Empire. Hence opinion had been divided, even among the patriots, as to the use of violence. Men like James Otis and John Dickinson earnestly counseled against it as not only unworthy of the cause but as being far more likely to alienate England than to induce concessions.[30] Moreover, as General Gage observed at the time of the Stamp Act, political mobs tended to become mobs with a roving commission. For this reason, he informed his London superiors, the well-to-do citizens, who had unleashed the terror, had drawn back in dismay when the rioters began pursuing objects of their own.[31]

Gouverneur Morris, on the opposite side of the political fence, struck a similar note when he wrote somewhat sardonically at a later juncture that

> the heads of the mobility grow dangerous to the gentry. . . . The mob begin to think and to reason. Poor reptiles! it is with them a vernal morning; they are struggling to cast off their winter's slough, they bask in the sunshine, and ere noon they will bite, depend upon it.[32]

When the First Continental Congress assembled, it also registered disapproval of "routs, riots, or licentious attacks upon the properties of any person whatsoever, as being subversive of all order and government."[33] By that time, however, the damage had already been done—and the benefit reaped. It is likewise revealing that even in the instance of the Boston Tea Party none of the actors publicly admitted complicity until more than half a century had elapsed.[34]

This ambivalent attitude toward mass violence cannot better be illustrated than in the case of that sterling patriot, John Adams. Deeply versed in jurisprudence, and law-abiding by nature, he, unlike his kinsman Samuel, shrank from the use of force and thoroughly distrusted nameless men whose brains were in their biceps. Instrumental in drawing up a protest against the Stamp Act for his home town of Braintree, he decided after perceiving its effects on the public of Massachusetts that "a man ought to be very cautious what kinds of fuel he throws into a fire." Yet, when popular uprisings throughout the continent killed the law, he wrote exultantly in his diary: "So triumphant is the spirit of liberty everywhere. Such a union was never before known in America."[35]

His doubts returned, though, when the dispute with Parliament presently resumed; and as attorney for the soldiers in the Boston Massacre, he sternly warned his countrymen against "the dangers of various kinds which must arise from intemperate heats and irregular commotions."[36] The Tea Party, however, once more reversed his attitude, causing him to exclaim, "This is the grandest event which has ever yet happened since the controversy with Britain opened. The sublimity of it charms me!"[37] In his emotional commitment to the American cause Adams had now arrived at a point where he consciously distinguished between good mobs and bad ones. "These private mobs," he wrote his wife, "I do and will detest," referring to "the insolent rabble" acting "in resentment for private wrongs, or in pursuance of private prejudices and passions." But, even so, he told her, he could approve of the political variety only "when fundamentals are invaded, nor then, unless for absolute necessity, and with great caution."[38]

But already he was beginning to wonder whether mob rule was not in any case preferable to abject submission to Britain (as though there were no middle ground), asking, "Will not Parlia-

[30] For Otis, see Frothingham, Richard, *Life and times of Joseph Warren*, 38–39 *n.*, Boston, Little, Brown, 1865; and for Dickinson, his *Writings* **1**: 323–325, Ford, P. L., ed., *Memoirs Hist. Soc. of Pa.* **14**, 1895.

[31] Letter to H. S. Conway, December 21, 1765, Gage, *Correspondence* **1**: 78–79; similarly, Cadwallader Colden to Sir Jeffrey Amherst, June 24, 1766, Colden, *Letter books* **2**: 111, *Coll. N.-Y. Hist. Soc.* **10**, 1877.

[32] Letter to John Penn, May 20, 1774, Force, Peter, comp., *American Archives*, 4th ser. **1**: 342–343, Washington, Clarke and Force, 1837.

[33] The Congress acted by reaffirming resolutions first adopted by a patriot convention in Suffolk County, Massachusetts. Continental Congress, *Journals* **1**: 36, Ford, W. C., and others, ed., Washington, Govt. Print. Office, 1904.

[34] Drake, *Tea leaves*, xcii.

[35] Adams, *Works* **2**: 153, 173.

[36] *Ibid.* **2**: 236.

[37] *Ibid.* **9**: 333, 1854.

[38] Adams, John and Abigail, *Familiar letters*, 13, Adams, C. F., ed., Boston, Houghton, Mifflin, 1875.

mentary taxation, if established, occasion vices, crimes, and follies infinitely more numerous, dangerous and fatal to the community?" [39] Soon, under the pen name of "Novanglus," he was proclaiming this opinion in the press and charging the Crown officials with accoutering their more deadly mobs "with red coats, fuzees and bayonets." Then, going the whole distance, he learnedly justified disturbances and insurrections for the public good by citing the writings of Grotius, Pufendorf, Le Clerc, Sidney, and Locke. Adams's own conclusion was that, when rulers transgressed the laws of God and man, it followed that "seditions, tumults and wars, are justified by the laws of God and man." [40]

[39] *Ibid.*, 14.
[40] *Boston Gazette*, February 13, 27, 1775.

Under the relentless impact of events the reluctant revolutionist thus came at last to vindicate unreservedly the strategy of direct action which he had once so deeply deplored. Even more illuminating was Adams's considered view of this phase of his young manhood long afterward when he was bowed with years. Nothing had offended his sense of orderly government so much as the popular fevers that had begotten the Boston Massacre. Yet half a century later, as he pondered the episode, he handsomely attested that "the blood of the martyrs, right or wrong, proved to be the seeds of the congregation." [41]

That, too, if more broadly applied to the revolutionary violence, must be the judgment of history.

[41] Letter to Jedidiah Morse, January 5, 1816, *Works* **10**: 203.

THE BRITISH COMMONWEALTH

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(*Read November 11, 1954*)

In 1943 General Smuts, the Father of the British Commonwealth of Nations, and Prime Minister of South Africa, in an address to the British Parliament, spoke of the Commonwealth in words which echo the famous passage in Shakespeare about England: "This royal throne of Kings. . . . This precious stone set in a silver sea. . . ." General Smuts' words were: "This great human experiment in political organization, this proudest political structure of time, this precedent and anticipation of what one hopes may be in store for human society in the years to come. . . ."

There are few problems of history and politics that hold greater interest than the inner structure and life processes of the Commonwealth. Here I can refer briefly only to two points: first, the nature and sources of the unity of the Commonwealth; and second, some recent threats from within to that unity.

The Commonwealth is the oldest international organization of states in existence. It has survived two world wars and the perils of peace. It is unique in its unbroken historical continuity, the loyalty of its members to each other, their solidarity in vital matters of common concern, the efficiency and invisibility of their group machinery and their abhorrence of constitutional contracts within the family of the Commonwealth.[1] Whenever the idea of such contracts has come up in their private discussions the prime ministers of the Commonwealth have always taken the view that "We have something that works better than contracts or treaties or constitutions."

THE BRITISH COMMONWEALTH AS A GREAT POWER

At the end of the Second World War the conclusion reached in an article in *Foreign Affairs*[2] was that the Commonwealth has "the marks of a Great Power." The conclusion holds good. For the neutralism and straying from the family circle, shown—in peace time—by India, has not affected seriously the solidarity of the other members. General Smuts and at times other prime ministers have spoken of the Commonwealth as a Great Power.[3] Mr. Menzies, the Australian Prime Minister, has used freely such phrases as "We are one people . . . one sword." The unity of the members of the Commonwealth has varied somewhat with time, circumstances, and leadership. But looked at historically, as an Australian Prime Minister said in 1944, "the degree of their unanimity is always approximately complete in matters of the greatest moment."

The Commonwealth is not, of course, a state under a single direction. It is a family group of free, independent, sovereign states, with such unity of spirit and identity of purpose that it functions as a Great Power. The people of the Commonwealth, and their leaders, spontaneously and habitually use the term "Family" in speaking of the Commonwealth. By long custom, extending far back into the nineteenth century, they have taken the family as one of their master symbols to express their sense of unity, of belonging together. By popular acclaim, and usage on official occasions, the king was "Head of the Family" long before the title "Head of the Commonwealth" was officially sanctioned by the prime ministers in 1949. The emphasis of the members of the Commonwealth, during their adolescence, on their freedom and independence may have misled opinion in some countries, especially in the United States, which still bases much of its thinking and assumptions in these matters on its own revolutionary history. But to the members of the British Commonwealth the solidarity of the family in the face of danger has remained as much a rule of life as freedom; and it is, indeed, the condition of preserving freedom. Thus they entered the war in 1939 with parliamentary unanimity in the United Kingdom, Canada, Australia, and New Zealand and a majority vote in South Africa.

[1] H. Duncan Hall, The British Commonwealth of Nations, *Amer. Pol. Sci. Rev.*, Dec. 1954.

[2] H. Duncan Hall, The British Commonwealth as a Great Power, *Foreign Affairs*, New York, July 1945.

[3] E.g., in the Union Parliament, 30 March 1944, the "Three Great Powers . . . the United States, Russia and the British Commonwealth."

COMMONWEALTH OF 100 PARLIAMENTS

Before referring to the sources of Commonwealth unity I want to mention a very recent example of it on the parliamentary side. I have just returned from some months spent in Africa with a hundred parliamentary representatives including members and speakers and men of all parties and races, from fifty Commonwealth parliaments. All the important parliaments were represented save India. We met in private conference at Nairobi and traveled together for many weeks in the countries from the source of the Nile in Uganda to the Cape of Good Hope. We saw together more than Africa. In innumerable conversations I saw through their eyes the Commonwealth. Never at such meetings (and I have had the privilege of being present as the only observer at a dozen or so of them in the past twenty years) has there been so much talk of the Family and the Commonwealth, so much interest and feeling for these things, so much mutual tolerance and good fellowship.[4]

THE COMMUNITY OF PARLIAMENTARIANS

Here was a cross section of the great "community of parliamentarians" of the Commonwealth. They were discussing such matters as defence, foreign policy, Commonwealth development, and other Commonwealth interests. The idea of the Commonwealth imposed itself on their discussions and they deliberated as if they were members of a Commonwealth parliament. They were certainly much more conscious than ever before that they were meeting as a Commonwealth. At Nairobi, for the first time in history, the Commonwealth Parliamentary Conference was opened with all the ceremonial of State normally associated with an opening of a national parliament: The representative of Her Majesty, the Queen, reviewing a guard of honour; the anthem; the flag; a parliamentary procession in uniforms of state and of Parliament, heralded by a fanfare of trumpets by the regimental band of the Black Watch. This use of Commonwealth symbols and ceremonial was much welcomed by the delegates, and there is no doubt that it contributed greatly to their feeling of group unity; they were identified with each other and communicated with each other by means of the symbols. And this all played a part in making them feel that in effect, aside from forms, they were meeting as a parliament of the Commonwealth. It was remarkable that in such a large body of men, representatives of so many parliaments, thrown together for so many weeks in close personal contact and discussing many matters of common interest with the utmost frankness, there were no clashes or ill temper.[5]

This "community of parliamentarians," which has its own constitution and governing bodies, is organized in sixty of the legislatures of the Commonwealth. I was asked to write for Africa and the Commonwealth parliaments a piece of parliamentary literature with the significant title, *Commonwealth of Parliaments*. It gave currency to a new and proud title, "Commonwealth of 100 Parliaments": for the number is now about 90 and mounts steadily.[6]

There is here a sense of history in the making—a supernational union taking shape. There can be no real supernational union unless a sense of belonging to a community can be created. The Atlantic governments strive therefore to cultivate such a community sense by encouraging the use of the word "community." Thus it has been used

[4] Parliamentary conferences of the older Commonwealth date back to the First World War. The first Commonwealth Parliamentary Conference of the enlarged Commonwealth took place in the autumn of 1948 with 85 delegates from 37 parliaments. At an historic ceremony in the Banqueting Hall of Edinburgh Castle, Asian and African members joined the others in speaking of the Family and responding to its symbols. The members sang together "God Save the King," and, with arms linked, "Auld Lang Syne." (On the way back to the Hotel I said to a young Irish Member of Parliament: "I was discreet. I did not look to see whether Ireland was singing 'God Save the King.'" And he replied: "Of course I was. I can't sing it in Dublin.") Again in 1954 in Johannesburg, at the end of the post-Conference visit to South Africa, the Members, including representatives of Pakistan and Ceylon, expressed the warmth of their feeling for the Family and again with linked arms sang "Auld Lang Syne."

[5] The holding of the conference in Africa, where the effects of racial and cultural differences were bound to come into discussion, proved to be a source of unity rather than dissension; for this made it possible for delegates to look together at the problem on the spot, instead of discussing it in the abstract away from Africa. It was agreed that national policies on such matters were domestic issues in which it was improper for other Members of the Commonwealth to interfere.

[6] *Commonwealth of Parliaments*, by H. Duncan Hall, with foreword by Sir Howard d'Egville, Secretary General of the Commonwealth Parliamentary Association. Nairobi, Government Printer, 1954. On the cover of the publication is the emblem of the Commonwealth Parliamentary Association which the delegates wore throughout Africa. It carries parliamentary symbols common to all the parliaments, the red of the Upper Chamber and the green of the Lower House, crossed with the mace and the black rod.

officially in such phrases as "The Atlantic Community," the "European Defence Community," the "European Community for Coal and Steel." Within the older Family of the Commonwealth there are many such functional communities. And in our own time the pattern of the Family as expressed in these communities shows some sign of spreading slowly into the new segments of the Commonwealth emerging in Asia and Africa. The sense of history in the making would indeed be justified if it could be shown that the strong pattern of the Commonwealth, the pattern of unity within freedom, can bridge the gulf between the cultures of the East and the West.[7]

THE SOURCES OF COMMONWEALTH UNITY

The pattern of the Commonwealth, freedom within unity, repeats on a larger canvas and a multinational scale the historic pattern of Britain. The British pattern is strong national unity combined with self government. Both parts of the pattern were carried out by British settlers to the colonies. They carried out a deep sense of still belonging to their own people at home; and in the isolation of great spaces this feeling became intensified rather than weakened. So that today the New Zealander or the Australian often feels he is more Commonwealth-minded and more British than the British; and in the sixth generation or more he still speaks of the "old country" as "home." Yet he combines this with a strong feeling for his own country.

Thus the sense of belonging to a larger family extended slowly from Britain to all the colonies settled from the United Kingdom; and it still goes on extending as other areas, once under British rule, are received into the Commonwealth. The sense of unity within the larger family was never interrupted or weakened by revolution: for the British pattern also provided for self government. The process of self government was achieved by an extraordinarily skillful and effective teamwork between the Crown and Parliament and the local authority in each colony. Thus self government in the colonies developed always and everywhere within concepts and symbols of unity. It also developed as *responsible* government, under a system which generated and maintained a strong sense of responsibility. The feeling of responsibility was not merely for the good government of the local territory, or country; it extended also to the whole family of the Commonwealth.

Thus the Commonwealth has done what no nation or empire in history has ever succeeded in doing. It has transplanted abroad a national union and transformed it without revolution into a union of self-governing nations bound by a supernational loyalty.

The Commonwealth came into being because the sense of belonging to a great community and to the ideological and symbolic structure which both expresses and continuously recreates that sense of unity, has been kept intact.

It is false history to suppose that this great result came from a process of "blundering through," in a "fit of absence of mind." True, it was not the result of any very conscious "grand design." The rare moments when there was talk of the need of constitutional blueprints were moments of peril. But throughout there has been a sure political instinct for the next step. And always there has been a strong feeling of the need to preserve the sense of belonging, with all the structure of common ideas, traditions, ideals and symbols, and the system of communications on which it depends for its existence. The building up of the complex and highly efficient (though little known) Commonwealth system of communications has been the great achievement of the last thirty years. The nerve centre of the system remains in London. For nowhere else are to be found the administration, the technical facilities, the prestige, and the vast experience necessary for the sure handling of a task of this kind.

THE INNER NATURE OF THE COMMONWEALTH

Let me first remind you by way of preface that the political union of a people does not consist in constitutional formulae or legal texts. It is something living in the hearts and minds of a people, something which draws its strength from that people's traditions, ideas, ideals, and interests, and the political symbols which represent and suggest these things. Such symbols to do their work must have currency; and so they are printed on the stamps and coins and displayed on public buildings. The changes are rung on them in the speeches of every leader; and they link together and are used by the governing groups of the country. So it is with the Commonwealth. Its inner nature can be described in a few sentences, simple enough in themselves but requiring much knowl-

[7] I see no good reason why this could not be possible, especially in the case of Ceylon and Muslim Pakistan, the historic roots of which are intermingled with those of the West. With Hindu India the gulf to be bridged is wider.

edge of the inner working of the Commonwealth system before their full meaning becomes clear.

The governing elements of the British Commonwealth of Nations consist of the groups in each Member State which carry on the work of Government. By this is meant the Ministers of the Crown, the Members of Parliaments (in which the Ministers also sit), the Law Officers of the Crown, the members of the Civil Service who serve the Crown, and the members of the Armed Forces who also are in the service of the Crown. All these governing elements are linked together in corporate fellowship—corporate because they are bound together by concepts and symbols of unity; fellowship because fellowship comes from many sources: from identification with each other through common symbols, from the carrying out of similar functions and through constant intercommunication; and from common ideas, traditions, ideals, interests and the emotions they arouse and sustain. All these things are expressed in common political symbols which play their part ceaselessly in uniting the members of each group, in uniting the groups with each other, in uniting the peoples they serve and in uniting the whole family of the Commonwealth. Each is identified with each and with all, let me repeat, in links of corporate fellowship, through constant communication and continuous identification with common symbols.

These symbols are focused strongly at several points. One is the Commonwealth itself (just as the United States is for its own people the main focus).[7a] Another is Cabinet Government and the Common Law. Another great focus is the common parliamentary system, derived, with all its traditions and procedures, its customs and its ceremonials, from the Mother of Parliaments at Westminster. But the master symbols, to which most of the other symbols are somewhere related, are the Crown and the Queen. The Queen to whom all look simply as Queen. The Queen, the Head of the Commonwealth. The Queen, the Head of the Family. And the Crown, in whose name (save in India and soon perhaps in Pakistan) governments govern, parliaments legislate, law officers interpret and execute the law. The Crown in whose name Ministers and officials and members of the Armed Forces act. The Crown, and the Queen, to whom the individual renders allegiance. Crown and Queen thus serve both as Master Symbols of Unity and the corporate bond between the Governments and the peoples of the Commonwealth and the vast community of individual "British subjects" or "Commonwealth citizens."

[7a] The United States has two master symbols—Constitution and Flag—which play little part, if any, in the symbolism of the Commonwealth.

COMMONWEALTH UNITY AND DIVERGENT CULTURES

This analysis of the complex living processes of the British Commonwealth draws up to the surface some of the inarticulate assumptions of its inner life. In the past there was no danger, but even an advantage, in leaving them obscure and unspoken. But now there is danger in such a course, for it puts them at the mercy of ill-considered change and crude constitutional surgery. The older members of the Commonwealth are most reluctant to initiate such surgery; but they may have it forced on them by latecomers with different assumptions, concepts of life, symbols, and interests.[8] Thus the adjustments required to accommodate in the Commonwealth the very different cultures of Asia and Africa involve a danger of weakening unity by the severing of bonds, or by weakening or destroying essential symbols. There are already signs that this will result in an inner core of older members, and an outer circle of more lukewarm members.

ASIAN REPUBLICS

In an effort to accommodate a widely divergent culture, and indeed civilisation, an Indian Republic has been grafted on the Commonwealth stock—not without the cutting away of tissues of unity and a weakening of Commonwealth symbols. Yet time has shown that India's assumptions and symbols, ideas, policies, and methods, diverge widely from those of the Commonwealth. By conceding a republic, with present and future damage to itself, the Commonwealth gambled on the as yet doubtful chance that it might win India for the Commonwealth.

The solution of an Indian Republic was accepted with great reluctance and misgiving by most of the Commonwealth prime ministers. It was commended later to their parliaments as an exceptional case. Yet from the outset in 1949 it was made abundantly clear in private that if this solution were adopted, Pakistan, despite the reluctance of its leaders and officials, would have to

[8] An example is the recent nationality legislation in the Commonwealth which weakened the "common status" by altering its basis.

follow suit and sever its relations with the Crown. Yet this Muslim State with historical roots in the same soil as the West, sharing in some degree similar assumptions, repudiating neutralism and taking its stand unconditionally with the Commonwealth, may prove to be a republic of a different sort.

HEAD OF THE COMMONWEALTH

There is still loose talk about republics in the Commonwealth preserving some symbols of unity, if they follow India's example in recognising the Queen as Head of the Commonwealth,[9] but such talk ignores the whole nature and function of political symbols. A political symbol cannot unify unless it reflects some degree of existing unity, and, by working consciously or subconsciously, continually recreates and enlarges that unity.

POLITICAL SYMBOLS MUST CIRCULATE

A political symbol cannot function unless it is in constant circulation. "Head of the Commonwealth," divorced from the Crown, and out of circulation, must remain more or less a dead form of words. It cannot serve as a real symbol of unity because it has a place neither in the constitutional and administrative structure of the state nor in its ceremonies and rituals, nor in the daily lives of the people. It is not a real part of the political vocabulary. For the circumstances of its birth ban it from the language of current politics. To come to life and serve as a political symbol it must circulate. It is an ancient piece of political wisdom that political symbols, if they are to play any role, must circulate in a hundred ways and not least on the coins and stamps. In all the foundation states of the Commonwealth the symbol of the Crown circulates and is in constant daily use by government, parliament, and people. And it plays unceasingly its dual role of reforging the unity of the people of each member state and reforging their feeling of solidarity with their fellow Commonwealth peoples.

It is a common error to think that a symbol cannot play its unifying role unless it is *liked* by people. Caesar's image on Roman coins unified the Empire whether Gaul or Goth liked it or not. An American president serves as a symbol of America to Americans even if half of them criticize him and voted against him.

A HYPOTHETICAL REPUBLIC

A republic in the Union of South Africa would again be a republic of a different sort. No doubt this is still a theoretical issue, but it is one of great interest for the future of the Commonwealth. The Commonwealth parliamentary delegates when they entered the Union ran into a heavy cross-fire between the South African parties on this subject. They were forced thus to reflect on the issues, which seemed to many of them to have profound and disturbing implications for the Commonwealth and the Union. The President of the Conference in Nairobi [10] referred to republicanism in the British Commonwealth in his opening public speech, in words spoken with deep conviction which drew general applause: "The ties of Commonwealth have never been stronger or more firmly joined than they are today—I cannot help feeling that the loosening of this link of allegiance to the Throne unties some of the closest and most precious bonds of unity binding together all of us who are united by that allegiance."

Republics in India and Pakistan are regarded with regret, but without resentment. Neither of them cuts off a large and resentful minority of British stock and tradition, and places them under alien rule, and in neither case was the Crown embodied in a national compact made in an earlier generation between its peoples.[11] As a student of history, I can only assume that a republic declared against the will of a very large British minority would create a bitter resentment that would smoulder for generations. Deep resentment would also be kindled and kept alight in people of British stock throughout the Commonwealth, and I think also in the United States. The step could not be taken in the case of the Union without far-reaching effects on the whole future of the country, on its economic development, its defence, and its security, on its reliability as an ally and as a safe and desirable area for the investment of capital. This perhaps makes it less likely that the step would be attempted, for it would leave South Africa as a lonely ungrouped state at war with itself, and faced with a new Great Trek, this time

[9] India, as the declaration of the Prime Ministers of the Commonwealth said in 1949, accepted "The King as the symbol of the free association of its independent member nations and as such the Head of the Commonwealth." A similar formula was adopted for Pakistan in January, 1955.

[10] The Rt. Hon. Harold Holt, Minister of Migration, Labour and National Service in the Commonwealth of Australia.

[11] The Crown was eliminated by India in the original act of framing its national constitution as an independent state.

of its English element, northward to the great new loyal British Commonwealth state of Rhodesia and Nyasaland.

THE IRISH PRECEDENT

Speculation about hypothetical republics is less fruitful than reflection about the meaning for the Commonwealth of past precedents. I refer to one that is recent—the republic of Ireland; and another so far away that its relevance for the Commonwealth today is forgotten—the republic of America.

When the Irish Free State was formed it cut off no large resentful British minority—since the minority in Ireland was given self determination and chose to remain within the United Kingdom. The Free State, no matter what the government of the day might be, was in fact used as the instrument for achieving Mr. De Valera's fixed purpose of a complete breach with the United Kingdom at no matter what cost to the Commonwealth. The first important breach came with the elimination of the Crown from the internal government of the Free State. The main breach came with neutrality in the war. For neutrality was a breach of the fundamental Commonwealth understanding of the solidarity of the family in time of mortal danger. Neutrality is incompatible with real membership of the Commonwealth, and the formal neutrality of Eire was followed by the inevitable consequence of secession. One further historical consequence of these breaches was the creation of an unbridgeable gulf between the republic of Ireland and that part of the United Kingdom known as Northern Ireland; for no mere words and formulae can wipe out the consequences of neutrality. Here I may be permitted to quote a conversation with one of the Irish Members of Parliament who came as guests to the Commonwealth Parliament Conference at Ottawa in 1952. When I pointed out the futility of raising the issue of partition on every conceivable occasion, he asked "What then is the solution? There must be a solution." To which I replied: "The gulf cannot be bridged by words and formulae. It could only be bridged by a third World War in which Ireland is not neutral." The rest of the conversation was: "As deep as that?" And my reply: "Yes. As deep as that and deeper."

THE AMERICAN REPUBLIC

The American republic was formed before the constitutional monarchy, the Crown in the modern Commonwealth sense, had come into existence.[12] The majority of the Americans, British stock themselves, cut off a resentful minority, who preferred the hardships of the Canadian wilderness to the breach of their common allegiance with the people of their mother country. One consequence was thus the Great Trek, of twenty thousand United Empire loyalists, northward to Canada. Another consequence I can sum up best in words spoken to me, in the presence of several Commonwealth parliamentarians, by Senator Warren Austin of the United States Senate, during the Commonwealth Parliamentary Conference in Ottawa in 1943. We had been discussing out on the terrace the role of the Crown in the Commonwealth. And after a long pause he said in words which I noted down at the time: "I don't suppose you know or can know what it meant to us when we broke with the Crown. Something went out of us. We fell apart from each other. We fought a Civil War. And I don't suppose that for a hundred years we recovered what we had lost." The remark was of the greatest interest to us and we discussed it for some time with him. It was the Crown, he pointed out, which had been the principle and symbol of unity amongst the American Colonies. It was the one thing which bound the separate colonies together. They had no common citizenship except through the bond of allegiance and when that bond was dissolved they became aliens to one another and for a time the colonies had to make treaties for the reciprocal recognition of each other's citizens. But as his remark showed there was something much deeper in his thought. The Fathers of the Republic knew that a state must have unifying ideas and interests and corresponding symbols. They deliberately created a set of new impersonal symbols like the constitution and the flag. And the people added the personal symbol of Uncle Sam. But generations were to pass before these artificial creations could play their proper functions in unifying the American people.

NEW AFRICAN SEGMENTS OF THE COMMONWEALTH

Crown and Parliament, the dynamic principles of the Commonwealth, continue to create new self-

[12] If the political inventions that created the Commonwealth in the nineteenth and twentieth centuries could have come earlier the result might have been different—but that was hardly possible. See C. R. Richeson, *British politics and the American Revolution*, Univ. of Oklahoma Press, 1954.

governing states. But we would be wrong in assuming that all of them are necessarily States with different and divergent cultures, which, while enlarging the Commonwealth, may weaken its unity. The Commonwealth parliamentarians discussed and explored on this African visit a new segment of the Commonwealth—Commonwealth Africa, or perhaps I should say *British* Commonwealth Africa. Their visits did not take them to African West Africa, still another new sector. The latter is very different from East Africa, with a different and a less certain destiny in the Commonwealth. It has no British settlements, and like Asia presents the problem of divergent new cultures in the Commonwealth. Its indigenous political organization is more advanced than that of tribal and primitive East Africa. It is richer from an agricultural point of view, and its economy, especially in the Gold Coast, may be able to support some of the cost of economic development of states on modern lines. The Commonwealth parliamentarians included West Africa in their view that the problems of Africa are Commonwealth problems which the whole Commonwealth must help to solve. But it was East Africa that they visited, the area called, with good reason, *British* East Africa, for the term applies with special force to those territories like the Rhodesias, Kenya, and Tanganyika where there is a solid core of British, or Commonwealth, settlement.

NEW FOUNDATION MEMBERS OF THE OLD COMMONWEALTH

It was here that the delegates made an important discovery: the old Commonwealth, which continues as a solid core within the enlarged Commonwealth, will receive a strong reinforcement in the shape of one or two new and potentially powerful British States. The old Oceanic Commonwealth with its five foundation members, the United Kingdom, Canada, Australia, New Zealand, and South Africa, all insular or peninsular territories, built and maintained by sea power, settled by European settlers who arrived in virtually empty lands, have now received a new foundation member, the Federation of Rhodesia and Nyasaland, and it will be followed later by some new state centred on Kenya, perhaps in time joined with Rhodesia.

The British settlements in East Africa are of the same kind (though later in date by the better part of a century) as those in the other foundation states, and they too took place in lands largely unoccupied when the settlers came. They regard themselves as much original inhabitants, as much *Africans*, as the native tribes who came—a little before, or about the same time, or later—into adjoining territories. The parliamentary delegates were greatly impressed with two things: the very high standard of European achievement in the territories they visited, and the extremely primitive character of the native tribes. On the spot and seeing with their own eyes, the delegates needed no convincing that the Commonwealth is firmly and deeply rooted in East Africa. The importance of these solid cores of European settlement is that outside them there is no common society, but only a multiplicity of tribes and languages so primitive that over two millennia of cultural development separate them from Western or Oriental civilisation.

It was abundantly clear to the parliamentarians that, if a higher law and authority were withdrawn, the tribes would quickly resume their traditional roles of attackers and defenders in the ancient African pattern of endemic warfare. The conclusion emerged from the visits and discussions that in East Africa (as in the Union, despite "apartheid") it will be the culture of the West, possibly modified in some areas by strains of Oriental culture, that will replace the primitive cultures of the native tribes. Much of the interests of the visits was in seeing this process at work. It was seen, for example, in the successful steps being taken to raise the level of efficiency of native agriculture—so low in most of the areas that it provides no surplus for a local market—and to reclaim the wasting soil; in the steps taken to eliminate human and animal disease; in the provision—at the expense mostly of the European taxpayer—of schools and hospitals, in the mushroom growth of whole towns of good African housing in areas where an economic surplus, as in the Copper Belt, makes such expenditure possible.

A NEW WORLD REGION OF HEAVY INDUSTRY

The rapid economic development on the way in South Africa and in Rhodesia are creating in this region formidable centres for the production of metals, heavy industry, and munitions. Great industrial developments of the most impressive character are taking place in the new industrial triangle just south of Pretoria. The new Orange Free State goldfield annual output of 100 million pounds sterling of new gold, and its 30 million

pounds sterling production of uranium adds to the economic strength of the Union.

But no less impressive is the economic potential of Rhodesia. Its copper belt develops rapidly into one of the greatest mining areas of the world. It has immense resources of coal and other strategic minerals and metals. The water resources of the Union are largely committed. The waters of the Great Zambesi River, three times that of the flow of all the rivers of the Union, are as yet unused. Here are possibilities of hydro-electric power, irrigation, and water for great industries, such as occur in few as yet undeveloped regions of the world. Moreover the Rhodesian Federation has other assets of great importance: political leadership of the highest quality; the solidarity of its people with Britain and the Commonwealth which assures investment in its resources; and a native policy which places no restrictions on the full utilisation of its human resources—black as well as white. No state in Africa has a better record in the matter of race relations, and its ministers make the proud boast that since the beginning of the century not a single life—black or white—has been lost in racial strife.

THE STRATEGIC IMPORTANCE OF AFRICA SOUTH OF THE SAHARA

On the strategic importance of Africa south of the Sahara the views of the greatest military genius Africa has produced, General Smuts, are of special importance. He saw this region as the fortress of Europe, available for Europe's defence or its recovery so long as sea power and air power are maintained by Britain and the United States. Geographically it is one of the world's great natural redouts, like North America and Australia, against power exercised from Eurasia. General Smuts gave his views immediately after Dunkirk on the strategic and military role Africa could play in the war. That the Island of Britain would hold he never doubted for an instant. Not only could it hold but Britain (and the United States) could reinforce the African base with munitions and munition-making machinery and Britain could furnish some troops. African armies could then be recruited and trained as he had done for his campaigns of the First World War in German Southwest and German East Africa. And from the base thus reinforced the Commonwealth could fight back for the recovery of Europe. General Smuts' military concept of Africa remains valid. Communications have brought the African fortress closer to Europe, and economic developments have greatly strengthened it.

In Africa one realised better that Africa was more than a base; it possessed also in Smuts himself the only possible alternative leader of Britain and the Commonwealth in the event of Churchill's death. He was indeed marked in London for such a role in the event of such a calamity. For he had played a part next to Lloyd George in the First World War and he was a many-sided genius, able to inspire men with his own indomitable will, and famous for his capacity for swift decision. He alone could have been the great animator of the Commonwealth, acceptable to the United Kingdom as Prime Minister. And this is a reflection which illustrates once again the essential unity of the Commonwealth.

THE *LEVIATHAN* AND SAINT-PIERRE'S *PROJET DE PAIX PERPÉTUELLE*

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THE Abbé Saint-Pierre's early biographers and other more recent writers disagree about the *Projet*. Those who admire his penchant for detail describe it as down-to-earth. Others see more clearly the self-defeating grandeur of his purpose. In spite of this difference of emphasis, however, each group assumes at the base of the system a belief that princes have a "higher reason" which may guide them to secure the public good rather than to satisfy their own selfish desires in "absolute independence" of the "reign of law."[1] Friedrich lucidly describes the doctrine and its prevalence: "The platonic inclination to turn to a 'teachable tyrant' had become for eighteenth-century rationalism the faith in an enlightened despot. It was the hope of Voltaire and the young Bentham, no less than of Bossuet and Fénelon. The good Abbé had shared it heartily."[2] According to this interpretation, first given by Jean-Jacques Rousseau and later accepted by Siégler-Pascal, Drouet, Houwens-Post, and others, Saint-Pierre does little more than "preach" the "sermon" of peace. His proposals are not thought to rest on any body of theory, but are seen only as a product of his own inventiveness in imagining a scheme to appeal to the altruism of the reigning monarchs of Europe.[3] The present paper, based on a fresh reading of Saint-Pierre material, much of it neglected in the past,[4] offers evidence that the Abbé did not prescribe in superficial fashion the measures of his plan, but derived them after a long period of study from a definite body of political theory, far removed from any "hopeful and senseless optimism" about the "higher reason" of princes.

After 1717, date of the last volume of the most detailed version of the *Projet*, Saint-Pierre did try vigorously to propagate its ideas. He oversimplified the presentation of them until he was accused of hoping to solve every dispute between sovereigns with five fundamental articles, the golden rule, and the slogan, "paradis aux bienfaisants." Largely because of the popularity of this caricature, the Abbé's activities as a student of government before 1717 have been ignored or not taken seriously. They reveal, nevertheless, another side of his personality and work.

In 1692 he obtained a position at court and began to amass information about many phases of the theory and practice of government. He took notes on the trade of France, Holland, and England from reports by deputies stationed in the major French seaports. He read many texts on commerce. He gathered intimate details about the government of Louis XIV and interviewed men actively participating in the domestic and foreign affairs of the nation (MS. 7929). More important to the formation of his political philosophy was his study of many legal and political works. He spoke of the writings of Plato, Bodin, Grotius, Pufendorf, Richelieu, Doria, and Hobbes. None of them, he found, had systematically applied the principles they had discovered to "les procédés entre souverains" (MS. 7929). Richelieu was superficial. Grotius and Pufendorf "discoursed" on law without proving anything; they failed to solve political problems by a series of logical steps, as in geometry, each supported by truths previously proved or self-evident. Such "preuves démonstratives," constructed by "l'esprit de raisonnement," could supplant "preuves prises de l'autorité, de l'exemple, de la vivacité des images des hommes éloquents" (MS. 7929). He attributed his own habit of carefully ordering his thought and of reasoning from "idées claires et distinctes" to his study of Descartes and to his training in the natural sciences. Because of this orientation, he spoke more highly of Hobbes than of the other writers he mentioned: "Thomas Hobbes, anglais, a plus approché de la bonne

[1, 2, 3] Carl Joachim Friedrich, *Inevitable peace*, 29, 165–166, 168–169, Cambridge, Mass., Harvard Univ. Press, 1948.

[4] Included are works of and about Saint-Pierre in libraries of this country and printed and manuscript material at Paris, Rouen, and London. In addition, the papers of Saint-Pierre in the Bibliothèque de la Ville de Neuchâtel have now been examined by the author: MS. 7929. They are important primarily because of the references they contain to the Abbé's sources. At times they permit a more conclusive statement than do the more available materials.

méthode de démontrer . . ." (MS. 7929). Under the influence of Euclid, Hobbes, too, had adopted the geometric mode of proof and presentation and had seen in it the means of breaking away from mere opinion and traditional political philosophy.[5] Yet the Abbé's approval was not without reservation. Hobbes' reasoning, he thought, was often false in point of form, "il nous a donné . . . beaucoup de paralogismes," because he did not grasp all of the principles. He regretted that Hobbes, like the others, had not dealt adequately with international relations.

These remarks, although they pertain to method, not to the ideas of political theorists, together with the copious notes on trade and the machinery of Louis XIV's government, indicate a serious preoccupation with research. The main threads of Saint-Pierre's thinking about man, society, and law, formed during this period of inquiry and meditation, need to be pieced together and traced to sources. Until the intellectual foundation on which he built has been uncovered, the motives and implications of his project cannot be understood.

To support his concept of government, the Abbé employs a psychology which is largely mechanistic. He accepts the Cartesian dichotomy, thinking substance and extended substance, and explains bodily movements and processes by analogy with a machine.[6] Unlike Descartes, however, he does not think man's soul can have much influence in directing and altering the mechanical order of events. Whereas Descartes insists that even people with the weakest souls can dominate the passions if the will uses appropriate weapons, "des jugements fermes et déterminés," [7] based on a belief in the existence of God, the immortality of the soul, and the responsibility of each member of society to his family, neighbor, and state, Saint-Pierre rejects any general assumption that man is capable of following the dictates of an intellect capable of perceiving ends other than those of his own selfish interest. Observation and experience tell him that reason is usually impotent: "il est très rare que la raison guérisse les passions" (MS. 7929). Most men are carried away by the violence of their desires and "au milieu du trouble que la passion cause dans leur âme . . . l'équité elle-même leur paraît injuste." [8] As a result, he refuses to utilize in the *Projet* the arguments of philosophy and religion. Men regard them as "pures spéculations; aussi, n'ai-je pas appuyé sur ses sortes de motifs . . . j'ai opposé passion vulgaire à passion vulgaire" (**2**: 105–106; MS. 7929). Freedom of the will is for the most part theoretical. Man is determined practically by his automatic reactions (desires and passions) to sense impressions, rather than by reason: "les passions naissent des choses sensibles, et l'intérêt ordinaire des hommes, c'est la satisfaction de leurs passions" (**2**: 104). Although he speaks of the will as a faculty and arrives at his essentially determinist position by stressing the corporeal data of the indeterminist Cartesian system, his virtual negation of the effect of reason and his subjugation of will to the passions bring his construct so far as its functioning is concerned in line with Hobbes' mechanistic psychology. Hobbes respects the opinions of Descartes, but sees man primarily as a creature of passions. He defines will as the "last appetite or aversion, immediately adhering to the action, or to the omission thereof" (Hobbes, xviii–xxii, xxvii, 38, 84; Strauss, 56).

From this point on the convergence of the major features of their doctrines is complete. The passages selected from each work for analysis are representative of its entire spirit. They deal with all the key points of the *Projet* and the *Leviathan*. Although the similarities of the two systems can best be seen by a topical comparison, the differences in scope and purpose between the arguments of Saint-Pierre and Hobbes should not be forgotten. Whereas Hobbes tries to demonstrate what national government must be in order to control effectively beings motivated by passion rather than reason, Saint-Pierre utilizes Hobbesian theory to argue the need for and practicability of a vast new union directed by a European assembly absolute in its authority and power.

Having discounted the influence of the teachings

[5] Thomas Hobbes, *Leviathan*, ed. Michael Oakeshott, 25, 30, 40–41, Oxford, Basil Blackwell, 1946; Leo Strauss, *The political philosophy of Hobbes*, 137, Chicago, Univ. of Chicago Press, 1952.

[6] In a letter dated at Saint-Cloud, July 1, 1698, MS. 7929, and in the *Histoire d'une apparition*, n.p., 1708, he gives a dualistic picture of man: soul located in the brain, corporeal machine, interaction between them by means of animal spirits in the blood, which enter the nerves and thus determine the particular movements that occur. He compares the circulation and replenishment of the blood to the movement of rivers and fountains fed by rain (MS. 7929).

[7] René Descartes, *Œuvres*, ed. Charles Adam and Paul Tannery, **11**: 367, Paris, Leopold Cerf, 1909.

[8] Charles Irénée de Castel, Abbé de Saint-Pierre, *Projet de paix perpétuelle* **1**: 4, Utrecht, Antoine Schouten, 1713–1717.

of philosophy and religion, the Abbé recreates the state of nature in search of a more efficient motivating force. Primitive men are creatures of violence in constant fear of losing life and limb, "animaux avides, défiants, jaloux, présomtueux, fiers, orgueilleux." To settle rival claims they have only the method of beasts, "la voye de la violence et du meurtre" (**3**: xxiv). Living in isolation, they are at the mercy of the seasons, wild animals, and their neighbors, "qui sont autant de bêtes féroces qui peuvent tous les jours leur ôter impunément leurs biens et la vie même" (**2**: 359–361). No one man is strong enough to gain permanent control over the others or superior enough in intellect to win the respect of the others. In this "système de la division et de la guerre," they pursue an unlimited right to everything they "judge necessary" to their own preservation. For want of a common authority, moral or political, any one of them can follow the maxims of the Czar: "il m'est permis de faire à l'égard de mes voisins tout ce que je 'juge' nécessaire pour ma conservation . . . par la ruse ou par la force . . . j'ai droit sur tous les pays de la terre, et en ce sens-là tout est à moi . . ." (**3**: 4–6).

This condition is Hobbesian in every sense, not the approximation to it given by a few of the other authorities Saint-Pierre had read.[9] For Hobbes, too, there is no significant gradation among men in reason and strength. Their natural sameness gives them equal hope for gain at the expense of one another and renders them rapacious, distrustful, and vain, characteristics corresponding to those the Abbé gives. Men invade and kill for profit, safety, and reputation, so that force and fraud are "virtues." There are no arts, letters, society, only continual fear and danger of death. Since there is no common power, there is no law, and without law there can be no injustice. "Every man has a right to everything," for "there is nothing he can make use of, that may not be a help unto him, in preserving his life against his enemies" (Hobbes, 80–85).

By positing this first chaotic state in which the basic motivation is self-preservation, the ground for limitless right and will to possess, the Abbé ties himself irrevocably to Hobbes. Such a concept presupposes the absence of higher reason, fixed natural law, and providence. Only if a higher power of some sort does not bind the conscience of man can the relation of men to one another be conceived as the right of each over the other instead of as mutual obligation. The Abbé's full cognizance of the extremeness of his definition of "independence" as lawless right, with its correlate, dependence on force, is shown by the fact that he gives expression to it through the Czar before himself admitting that he must assume this absolute exposure of each to the will of each if he is to justify his plan.

Natural man's predicament produces a scale of negative values, all of them related to fear: "les plus grands maux qu'ils aient à craindre, c'est la perte des biens et la perte de la vie. . . ." Of these, fear of loss of goods, that is, of an enemy's hope to gain, is less strong: "la dépendance qui naît de l'espérance est beaucoup moindre . . . la plus grande de toutes les dépendances, c'est de dépendre pour sa vie de la volonté d'un ennemi mortel . . ." (MS. 7929; **3**: 72, 80). The desperate need of each for freedom from violence becomes a basis for an initial limitation of right. Fear of violent death forces man to use his reason (instrumental), the motivation is sensuous and emotional, not related to higher reason, to find a rule, "la première règle de l'équité naturelle," necessary to survival, "qui est de n'user jamais de

[9] For Plato there is a significant gradation in reason among men and a fixed universal law. Aristotle sees man as "by nature a political animal." Bodin's state of nature is one of war. Unlike the Abbé, however, he explains it by the Fall. He assumes the presence of God, a law of nature, and reason, "qui est toujours conforme à la volonté de Dieu" (Jean Bodin, *Les Six Livres de la République* **1**: 19, Gabriel Cartier, 1608). Grotius says natural law or right is a dictate of right reason and man a social being by nature (Hugo Grotius, *De Jure Belli Ac Pacis Libri Tres* **2**: 11, Oxford, Clarendon Press, London, 1926). For Pufendorf, the state of nature is one of peace. Sociability as well as self-preservation motivates man, who can "heed not merely the craving of his passions, but also the call of a reason which does not measure itself simply by its own advantage . . ." (Samuel Pufendorf, *De Jure Naturae et Gentium Libri Octo* **2**: 169–172, Oxford, Clarendon Press, London, 1934). Bossuet sees man as basically sociable and initially innocent, although original sin inclines him to war and makes civil government necessary (Jacques-Bénigne Bossuet, *Œuvres* **1**: "Politique tirée de l'Ecriture Sainte," Paris, Didot, 1852). Locke says the state of nature has a law of nature to govern it "which obliges every one" (John Locke, *Two treatises of government*, 123, New York, Hafner, 1947). Fénelon thinks all peoples are brothers and "tout le genre humain n'est qu'une famille . . ." (François de Salignac de La Mothe-Fénelon, *Les aventures de Télémaque*, ed. Albert Cahen, **2**: 48, Paris, Hachette, 1920). Doria, unlike Saint-Pierre, speaks of the Fall and thinks man has an "inclinazione naturale all' unione fra gli uomini . . ." (Paolo Matteo Doria, *La Vita Civile*, 21, Augusta, Daniello Hopper, 1710).

violence contre aucun de ses pareils, comme il ne voudrait pas qu'aucun d'eux en usât contre lui" (3: 52–54). This minimal renunciation of right is called a duty, "le premier des devoirs du citoyen." Reflecting at first the warring condition by its particularity, the precept is soon generalized to become the so-called silver rule which covers all situations and by which each man abandons as much of his natural liberty as his neighbor. Applying it, men see the need for accepting an arbitrator to settle their disputes: "nul ne prétendra être juge légitime dans sa propre cause" (3: 51–52). Although all men should want to practice equity, since neglect of it means the continuation of violence, there can be no assurance they will put the precept into effect before the establishment of civil government. Men are often unable to apply the rule even though they may want to, because of "l'ignorance où ils sont de ce qu'ils doivent . . ." (3: 55). If there is no "surêté suffisante" that other men must obey the rule, the "just" man cannot obey it, for obedience under such circumstances denies his right to self-preservation. Without an executive agent, conformity is uncertain, because the rule is found by reasoning, and the passions are stronger than reason in man. In his judgment of what is best in a given situation he may revert to the old methods, violence and murder (3: 41–42).

This first step in man's creation of law corresponds to Hobbes' explanation of the origin of the law of nature. He says that "fear of death," desire of goods for "commodious living," and a "hope by industry" to obtain them direct men to peace. The most important of these passions is fear, not just of death, but "which is worst of all, continual fear and danger of violent death." Through his reason he finds "convenient articles of peace," called laws of nature (Hobbes, xxxiv, 82–84). These laws, nineteen in all, are in reality only precepts or general conclusions "concerning what conduceth to the conservation and defence" of man (*ibid.*, 84, 104). They can be summed up in the "law of the Gospel" or negatively in that "law of all men, 'quod tibi fieri non vis, alteri ne feceris'" (*ibid.*, 85, 103). Such a relinquishing of right when agreed upon by men becomes a duty, defined as "not to make void" a voluntary act of renunciation (*ibid.*, 86). Hobbes' sixteenth law is the one the Abbé emphasizes, "that they that are at controversy, submit their right to the judgment of an arbitrator" (*ibid.*, 102). These "laws" are "binding only to a desire they should take place" and do not oblige necessarily in practice. A man who keeps his promises when others do not becomes "a prey to others." Furthermore, the laws of nature, even though they arise from fear, are "contrary to our natural passions, that carry us to partiality, pride, revenge, and the like" (*ibid.*, 103–104, 109).

In the precedence they give to right, Hobbes and Saint-Pierre have a basic similarity. For both, the universal claim of nature, founded on the right of the individual to self-preservation, comes before law or obligation of any sort (Hobbes, lii, liii). There is originally no higher standard or rationality, only each man's fear of death and will to avoid it. This passion later gives rise to a rule of prudence, justifiable before all men and acceptable to them as a duty, "le premier des devoirs" for Saint-Pierre, an obligation in "foro interno" for Hobbes, although for neither does the silver rule actually become a law binding in effect until it is made part of the positive law of a civil society. Other theorists, Bodin, Grotius, Pufendorf, Doria, and Locke, hold a very different point of view. In the tradition of Plato and Aristotle, they assume law precedes right. Spinoza reaches another extreme when he identifies law, right, and force.

Violation of the rules of equity can be prevented only by threat of punishment, "autrement il n'y aurait plus d'équité" (3: 52–53). To regularize an authority capable of inspiring fear, men agree to lay down their rights to all things in favor of a third party, by "s'être mutuellement cédé et abandonné . . . tous les droits et toutes les prétentions qu'ils peuvent avoir les uns contre les autres" (1: 297–298). It is a voluntary agreement, "dépend uniquement de la volonté," among equals fearful of one another, "il y a pour eux un plus grand mal à craindre s'ils ne le choisissent . . . leur destruction totale" (3: 63, 64). They are not influenced in this decision by fear of the person they accept as arbitrator: "cet arbitrage . . . a été 'convenu' entre pareils . . . non une obéissance d'inférieurs à un supérieur" (3: 63). The creation of an arbitrating authority, "cette invention de l'arbitrage," is artificial and its task artificial: "que fait l'arbitrage, si ce n'est de suppléer par art à ce qui leur [aux hommes] manque [connaissance de la justice] du côté de la nature" (3: 55). Self-interest and the transference of right by contract are the only bases for the authority of the new agent: "ainsi c'est leur intérêt particulier qui est l'unique motif de leur convention, qui est l'unique

fondement de l'autorité qu'ils donnent à leur arbitre" (3: 64). The contracting individuals accept by majority vote, "à la pluralité," one of three forms of government, monarchy, "élection d'un seul pour arbitre," or an assembly made up of some of the whole number, "aristocratique," or of all the members, "démocratique" (3: 45, 63). Since the greatest threat to peace is division of authority and power, monarchy is preferable, so that "toute autorité réside en une seule tête . . . de peur que le partage de l'autorité n'allume la guerre" (2: 344–345). Republican states have advantages, but are "bien plus sujettes à la maladie de la division et des parties" (MS. 7929; 1: 263–264, 289–290). The central authority, whatever the form selected, is not a party to the covenant and is not bound by it. Even under tyranny, civil war is "un remède pire sans comparaison que le mal même" (2: 221; MS. 7929). The authority of the new government is absolute, including powers to make, abrogate, interpret, and enforce laws which each citizen is powerless to disobey: "il faut qu'il obéisse à la loi qu'il s'est imposée, parce qu'il y a une loi, une force supérieure qui l'y contraindrait malgré lui" (1: 19–20). Thus liberty, which is defined as "exemption de contrainte," assumes an innocent appearance as "le pouvoir que quelqu'un a de faire quelque chose qui lui plaît, sans opposition, et sans avoir à en craindre les suites de la part de ses voisins" (3: 89). Laws prevent men from violating the rules of peace, but where the law does not limit their acts, they have liberty. Members do not acquire from this new reign of law "concorde" and "tranquilité," but "exemption de violence," which is enough to give them felicity, "la plus grande félicité qu'un nouvel établissement puisse jamais leur procurer" (1: xij; 3: 150). Through trade, manufacture, tillage of the soil, inexhaustible riches are opened up to them (MS. 7929; 2: 47).

According to Hobbes, too, "justice, equity, modesty, mercy" are not observed unless they are upheld by fear of some power (Hobbes, 109). In describing the origin of the coercive might behind law, he opposes commonwealth by institution to commonwealth by acquisition. By the latter, men subject themselves to "him they are afraid of." By the first, men covenant among themselves by a vote of the "major part" to give to a man or assembly of men "the right to present the person of them all." They authorize the actions and judgments of their representative in order to live "peaceably amongst themselves" (*ibid.*, 113, 129). It is from this "institution" alone that the elected sovereign derives "the rights, and faculties" he has. It is a contract of each to each, "not of him to any of them." [10] By it men establish the artificial state, Leviathan (*ibid.*, 112–114), which in form can be monarchy, aristocracy, democracy,[11] although monarchy is preferable since "a monarch cannot disagree with himself . . . but an assembly may, " to such an extent as to produce civil war (*ibid.*, 123). The three, however, do not differ in power, but only in the "convenience or aptitude to produce the peace" (*ibid.*, 122). As a result of this transference of right the sovereign has so much strength "that by terror thereof he is enabled to form the wills of them all" (*ibid.*, 112). Liberty, as for Saint-Pierre, is "absence of external impediments," "absence of opposition." Wherever the sovereign has not prescribed rules, the subject has the "liberty to do or forbear" in seeking a more "contented life" (*ibid.*, 84, 136, 143). The purpose of commonwealth is not only security but "felicity," which means "continual prospering" (*ibid.*, xliv, 39, 109).

In their insistence that precepts cannot be called law until they are supported by force, description of the establishment of authority, preference for monarchy, and definitions of liberty and felicity, Hobbes and Saint-Pierre are in close agreement. For both, law is the consequence of the unlimited right which places every man in fear of violent death. The state is no longer natural in origin, a reflection and instrument of law, but is instead a

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[10] For Bodin, there is no contract among equals, but victory of the most powerful and his followers over the rest. The followers become subjects; the conquered become slaves (Bodin, *op. cit.*, 68). According to Pufendorf, there is an additional contract, which Saint-Pierre and Hobbes omit, by which "the rulers bind themselves to the care of the common security and safety" (Pufendorf, *op. cit.* 2: 975). For Bossuet, monarchical authority is analogous to paternal authority and monarchy not artificial, but the most natural form of government. Absolutism is balanced by "un vrai contrepoids de la puissance," fear of God (Bossuet, *op. cit.* 1: 428, 430). Locke says the sovereign is bound to govern by established standing laws. Rebellion is justified when kings use force without right (Locke, *op. cit.*, 186, 239). Doria believes men sought the protection of the strongest (Doria, *op. cit.*, 92).

[11] Saint-Pierre conservatively follows the classic division, as does Hobbes, who says that there are other names corresponding to these three, but they are "the same forms misliked" (Hobbes, 121). Montesquieu in *De l'esprit des lois*, 1748, will refuse to see despotism as a simple perversion of monarchy and will establish between them a difference in kind, making a fourfold division, democracy, aristocracy, monarchy, despotism.

preliminary to the establishment of law, an "invention" for Saint-Pierre, an artificial man for Hobbes. Since there is no significant difference in reason among men, no innate superiority of intellect, a man or assembly is arbitrarily chosen to become the artificial reason of the group. This representative the Abbé calls the "arbitre" who furnishes "by art" the knowledge of justice "men lack by nature." Hobbes says men set up, for "right reason, the reason of some arbitrator, or judge" for "want of right reason constituted by nature" (*ibid.*, 26; Strauss, 155–160). For both, the function of the arbitrator is not merely to judge, but to exert will in enforcing the peace, legislating, interpreting, executing the law, bringing to bear overwhelming power for fear that artifice may fail and the passions again take control.

Among nations, according to Saint-Pierre, the lawless state of nature persists. Each sovereign is a victim of his liberty to keep or not to keep his promises. Hobbes, too, says that every sovereign in protecting his people has the same right that any "particular man can have in procuring the safety of his own body." As a result, rulers must have "their forts, garrisons, and guns upon the frontiers of their kingdoms" (Hobbes, 83, 232). But he does not think the inconvenience of war to nations of men creates the same need for control that the original natural condition did. Because rulers uphold the industry of citizens by war, "there does not follow from it, that misery, which accompanies the liberty of particular men" (*ibid.*, 83). Saint-Pierre, to the contrary, by attributing to sovereigns the Hobbesian motives of "particular men" extends civil society to the international level.

Sovereigns, as Hobbes points out, are not only representatives of the men who chose them, but are natural persons, subject themselves to fear of death and hope of gain (*ibid.*, 122). Saint-Pierre uses these two emotions. He repeatedly speaks of "la chute et la ruine des maisons souveraines," "le bouleversement de leurs états" (**1**: 10–11). When rulers do not have enemies "à craindre au dehors," they must worry about internal wars: "ne fut-ce pas l'esprit de rébellion qui fit périr Henry III à Saint-Cloud, et même Henry IV à Paris? . . . Charles premier à Londres?" The ruling houses are "comme les villes bâties auprès des volcans" (MS. 7929; **1**: 176, 250). Francis I did not foresee that for more than forty years his family would be "à deux doigts d'être chassée du trône, et d'être même entièrement exterminée" (**1**: 184). In addition, war impoverishes nations, and national poverty is the poverty also of rulers. Trade and manufacture, not conquest, are the real sources of wealth (MS. 7929; **1**: 270–273, 320–324; **2**: 87–88, 306–307). King, member of aristocratic or democratic assembly, as natural persons, then, even more than as sovereigns interested in preventing a return to the state of war, should, like the individuals who enter into civil society to procure "the benefit of peace," the only universally desired good (Hobbes, xl; 109), be ready to enter into a European organization with characteristics comparable to those of the national government.

The new assembly, aristocratic in form, since it represents only a part of the whole number of people involved, the sovereigns, is absolute in its authority and power: "une autorité permanente infiniment supérieure . . . qui maintienne toujours en vigueur la loi nouvelle . . . qui ne laisse à personne aucune espérance de pouvoir jamais la violer impunément . . ." (**1**: 119; **3**: xiv; MS. 7929). Acceptance of the authority does not compromise national sovereignty more than the contract among individuals compromises individuality. Rulers exercise their own wills freely and as equals in establishing the government to make "peace inalterable" (Fundamental Article 1). Just as natural persons, according to Hobbes, can agree to surrender their right unconditionally, so sovereigns, Saint-Pierre reasons, can transfer their right in the same way to a higher authority by an agreement among them, "la signature de ces articles dépend uniquement de la volonté des souverains" (**1**: xij). As in the case of individuals, the transference of right is not to a natural person feared by them, but to an "invented" agent, "l'arbitre," an assembly of deputies which represents them, decides matters by majority vote, and acts in their stead. Within their own borders and without, wherever laws are not laid down to limit their activities, they are free, "sans opposition," to pursue their felicity, competing and amassing economic wealth through the uninterrupted industry of their citizens.

Furthermore, although endowed with absolute authority and power, the assembly is to be a lawgiver, its rule like that of Hobbes' sovereign, "not arbitrary, but the rule of law" (Hobbes, lvii). Fundamental Articles Seven, Eight, Ten, Eleven and Twelve establish its right to legislate, abro-

gate, interpret, and enforce laws with respect to members and their subjects (1: 320–350). There is no higher standard. "La nouvelle loi" is the only measure of justice, that is, the rendering of what is due. Without it, there is only "un chaos de droits," in which any ruler can say "nulle loi ne peut attribuer à aucun de mes voisins aucune propriété d'aucune chose à mon préjudice . . ." (1: 317; 3: 4–6). National law is subordinate to the new. The renunciation articles made at Utrecht in 1713 to prevent the joining of the sovereignties of France and Spain, are to be enforced even though they disregard "un article de la loi salique" (3: xiv). The law must, however, comply with two principles, necessity and equity, the only criteria Hobbes recognizes (Hobbes, xl–xli). The twelve fundamental articles are "nécessaires," that is, they cannot be omitted without threatening the new government. For Hobbes, a fundamental law is one which "being taken away, the commonwealth faileth and is utterly dissolved" (*ibid.*, 188). A law is unnecessary when it restricts activities which do not threaten the peace. An equitable or evenhanded law for both Hobbes and Saint-Pierre follows the spirit of the first rule man found in his fear.

By law, from the moment the assembly is established, the form of the government of every state is to remain unchanged (Fund. Art. 2; 1: 290–293). Any attempt to overthrow the existing monarchy, aristocracy, or democracy is to be put down by force. Within the Hobbesian framework the provision is defensible. It is equitable since it applies to every ruling body. It is a necessary means for stabilizing the governments of Europe, since there is no other rule which effectively binds the conscience of man, and sovereigns are not always able to prevent rebellion. Obedience, not the form of a state, is important. "L'esprit de rébellion," "ces terribles révoltes," "cette espèce de maladie d'état," can be stopped only by "une peine très grande et absolûment inévitable contre les conspirateurs" (1: 250; MS. 7929). By trying to change its form, the people may destroy their state (*cf.* Hobbes, 222).

Other laws are designed to eliminate friction. The boundaries of states are fixed permanently by Articles Three, Four, Five, and Six (1: 293–319). After the signing of the contract no territory is to be added or given away. No exchange of land can be made without the "consentement et sous la garantie de l'union." No sovereign shall acquire two sovereignties. These provisions, although they arbitrarily fix the status, are equitable, since by them each relinquishes his right to the possessions of each. They are also necessary. Before transferring their rights to the new government, sovereigns have only "possessions actuelles," not property. Each can claim everything in the state of nature, "parce que je le veux." To put an end to rival claims, to let each know what is his, "il faut un point fixe pour borner le 'mien' et le 'sien' . . . la possession actuelle est un point très visible . . ." (1: 309). This is the basic problem of war. Peace depends ultimately on sure, permanent, contented ownership (1: 3). Once the assembly is instituted, men have "une autre règle que leur volonté, c'est la loi" (1: 12–13). They are obliged to respect frontiers guaranteed by an authority higher than their own, "contre laquelle un membre voudrait inutilement se révolter." Because of Article Ten, which provides for an army, each member has for the first time "une sûreté suffisante" that his state will not be dismembered by a neighbor. The new government itself, however, may take away property from any ruler who invades the territory of another (1: 331). Similarly, for Hobbes, "propriety," which men acquire "in recompense of the universal right they abandon," is the key to peace at the national level (Hobbes, xli, 94, 117). It does not begin until authority and power are concentrated in one person or assembly (*ibid.*, 94). The distribution of land is made equitably, although arbitrarily, not according to justice conceived as rationality (*ibid.*, 162). Moreover, although other subjects are excluded from the use of an owner's land, the sovereign himself, for the common good, can declare any allotment void (*loc. cit.*).

By law, membership is made irrevocable and compulsory. A prince cannot withdraw because he objects to a ruling. After fourteen of the twenty-four members to participate in the organization have joined, a dissident is to be declared an enemy, a threat to the security of Europe, and warred against until he is completely dispossessed (Fund. Arts. 8 and 9). No one can take back the right he has surrendered even though a verdict may seem unjust. There is no contract which binds the central government. The latter cannot be bound and at the same time have absolute authority (*cf.* Hobbes, 114). As for compulsory membership, Saint-Pierre argues that a man wants to increase his territory or to conserve it. If he prefers to stand alone in order to increase it, "ce

ne peut être qu'aux dépens de ses voisins; ainsi ils sont en droit de le regarder et de le traiter comme leur ennemi" (1: 331). Hobbes speaks specifically to this point. Whether at the time of the covenant a person "be of the congregation" of men or not and whether his consent "be asked or not," he must either submit to their decrees, or be left in the condition of war, where he may "without injustice" be destroyed by any man. He places himself in a position where he depends on "his individual power against the concentrated power of all others" (Hobbes, xxxix, 115).

The new community is Christian. The Czar is admitted for reasons of security and commercial advantage and because his people accept one all important article of faith: "le christianisme de ses états est fort différent du nôtre, mais ils espèrent le salut par Jésus-Christ; ainsi ils sont chrétiens" (1: 372–375). Religious controversy is forbidden, because only "le temps découvre la vérité," and the central authority must keep disputes over obscure matters of faith from erupting into war: "il suffit dans les commencements d'imposer silence à tout le monde . . . et voilà ce que fera infailliblement dans tous les états de l'Europe la prudence et l'autorité de l'union" (1: 292). The Pope is given equal representation with the other twenty-three members, but only as sovereign of the territories he possesses, the Papal States. He is as subordinate to the European government as the others. Hobbes, in describing his Christian commonwealth, is concerned primarily with actual religious beliefs and reduces them to "the unum necessarium, only article of faith, which the scripture maketh simply necessary to salvation . . . that Jesus is the Christ" (Hobbes, 388). Although men's private beliefs are not the sovereign's province, he has the right to control public worship, suppress superstition and heresy, and stop discussion about religion (Hobbes, 242, 243, 306). Since there is no other government in this life, "neither of state, nor religion, but temporal" (*ibid.*, 306), the Pope has valid authority only "in the territories whereof he is himself the civil sovereign," or where another ruler has accepted him as "the chief pastor under himself" (*ibid.*, 434).

The contract once signed is not conclusive, but will constantly be questioned by princes under the influence of their passions, "les princes ne sont après tout que des hommes" (1: 325). Besides maintaining an army to put down rebellion within states, punish sovereigns who violate the peace, and protect the European community from enemies on its borders, the new government takes other precautions to keep its members and their subjects obedient If the subjects of a member support him in an unauthorized war, they are punishable by death or life imprisonment. Rewards await those who desert to "la commune patrie" (1: 375–376). In time of peace no sovereign maintains an army of more than six thousand soldiers from his own nation. The central authority stations a resident in each province of two million people (1: 364–367). His task is to "veiller" in order to prevent a sovereign from surprising his neighbor by "un armement grand et subit." Every year on the same day, each sovereign renews in the presence of ambassadors and residents of the assembly his oath of loyalty to "cette espèce de république." The Abbé intends a supranational ruling body comparable in absolute power and authority to Leviathan on the national level. He does not have in mind a mere concert of nations joined by a common pledge: "traités de ligues, d'alliances . . . n'ont rien de solide qu'autant que dure la volonté des alliés . . . ne sont point des sociétés permanentes" (1: 8). By its police measures the central government is to assure its continued success in giving its members "sûreté suffisante." Otherwise, its existence is no longer justified, "inutilement on prétendrait maintenir l'union." Similarly, for Hobbes, obligation of members to the central authority is "understood to last as long, and no longer than the power lasteth, by which he is able to protect them" (Hobbes, 144).

The Abbé composed the plan for European government after a long period of study between 1692 and 1717, during which he read important works dealing with political and legal theory. Comparison of the intellectual materials on which the *Projet* is founded with doctrines presented by other writers in the field makes it clear that his proposals are not simply a product of his own inventiveness in imagining a scheme to appeal to the altruism of the reigning monarchs of Europe. The project is supported by a definite body of theory which consistently follows to the national level ideas about man, social contract, and sovereignty expressed in the *Leviathan*. The new European republic itself is an extension of the Hobbesian civil commonwealth.

Given this fact, two "inconsistencies" or "incohérences" in the *Projet* disappear. Assuming that Saint-Pierre believes in a fixed natural law,

critics find that he errs when he proposes to perpetuate the forms of governments, because he thus creates an unjust system in which subjects are unable to resist tyranny or establish the kind of rule they want. Others think he could not have understood the implications of Article Four, which by preserving the status and rendering earlier usurpations permanent "violates the principle of justice." [12] Although Saint-Pierre understands the frame of reference which leads to such criticism, he never tries to work within it. For him, as for Hobbes, form of government is less important than the absoluteness of its authority and power. Monarchy under a tyrant is preferable to the state of war (2: 221). Men who have agreed to surrender their rights unconditionally cannot complain of injustice. Preserving the status is equitable and necessary. It is also arbitrary, but not unjust. Before the establishment of the Union, possession is fluid and no right becomes attached to territory lost, since there is no binding law of any kind. These features are not inconsistencies, then, but outgrowths of the intellectual substance on which the Abbé's system rests.

Contrary to the opinion of the Abbé's early biographers and more recent writers, Saint-Pierre does not rely on enlightened despots, platonic higher reason of princes, or natural law conceived as rational standard. His argument is based on man's fear and hope for selfish gain, not on altruistic concern for the public good. For self-preservation, conservation of their line, and uninterrupted economic growth of their states, sovereigns by contract transfer their right to an assembly with absolute authority and power. By its overwhelming strength the new government maintains obedience or crushes members who violate European positive law. Underlying the structure is a concept of man as creature of passions. Driven by fear, he uses his reason to escape the condition of violence which results from the equality of all men in intellect and strength, the absence of law and obligation, and the right each has to everything. Once men agree on articles of self-preservation, right is transferred arbitrarily to an artificial agent, the arbitrator, which invents an artificial law and is prepared to use physical force in executing it. There is no higher standard by which to measure law than simply equity and necessity, both of which are derived from man's reasoning about his predicament. Positive laws, since they are formed by the will of the authority men select as terminal, cannot be unjust. The government's highest duty, success in maintaining the peace, ultimately determines what is just. The appearance of these aspects of Saint-Pierre's system, with its emphasis on passion, right, and invention rather than on reason, law, and nature, opens to question the appropriateness of the position assigned to him in the past among the seventeenth and eighteenth century rationalists.

Ridiculed in his day, the Abbé was more sympathetically heard during the late nineteenth and early twentieth centuries, but this does not mean the theory behind his project was extremely advanced. In his political thinking he never broke away from beliefs common in his age. He was original in the sense that he sought to apply well-known premises to the solution of problems admitting no solution in the minds of his contemporaries. When in the pursuit of "bienfaisance" he transformed his vision of world peace into message and scheme, the Abbé was influenced in no small measure by the doctrines of Hobbes.

[12] S. Siégler-Pascal, *Un Contemporain Egaré au XVIIIe siècle*, 37, Paris, Rousseau, 1900. Joseph Drouet, *L'Abbé de Saint-Pierre, l'homme et l'œuvre*, 125, 131, Paris, Champion, 1912. Elise Constantinescu-Bagdat, *Etudes d'histoire pacifiste* 2: 120–121, Paris, Presse Universitaire, 1925. Elizabeth Souleyman, *The vision of world peace in seventeenth and eighteenth century France*, 83, New York, Putnam's Sons, 1941.

SOME LOCAL SCHOLARS WHO COUNSELLED THE PROPRIETORS OF PENNSYLVANIA AND THEIR COMMISSIONERS DURING THE BOUNDARY SURVEYS OF THE 1760's*

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In a recent paper [1] there were presented all of the British scientists and technologists who are known to have advised the proprietor of Maryland and those of Pennsylvania during the period when the final survey of their common boundaries was being organized, equipped, and staffed. The American scientists and technologists who participated in this endeavor are still to be presented.

On July 4, 1760, there was enrolled in the High Court of Chancery an indenture of agreement which Frederick, last Baron of Baltimore, and Thomas and Richard Penn had just signed. It was their final agreement to survey and mark their common boundaries. On the following day Baltimore named seven commissioners from Maryland and the Penns seven from Pennsylvania and the Three Lower Counties, to supervise together the surveying and marking of the boundaries. Ten weeks later news of the events of July fourth and fifth in London came to Philadelphia on H. M. S. *Mercury*. And with a letter [2] of September 15 Governor James Hamilton of Pennsylvania transmitted to Governor Horatio Sharpe of Maryland a copy of the agreement of July 4 and the commissions sent to him by Lord Baltimore. In his letter Governor Hamilton gave Governor Sharpe the names of the seven commissioners who would represent Pennsylvania and asked him to suggest the time and place of the first joint meeting. Four days later Governor Sharpe acknowledged [2] the receipt of Governor Hamilton's letter and of the documents which accompanied it, gave him the names of the Maryland commissioners and promised an early selection of the time and place of the first joint meeting of commissioners.

It appears that the Pennsylvania Commissioners began at once to prepare for their meeting with the Commissioners for Maryland for on October 22, 1760, the Rev. William Smith, Provost of the College of Philadelphia, wrote [3] to Thomas Penn as follows:

> At the Desire of the Commissioners for running the Lines, I have within this Fortnight past carefully examined all the Schemes offered for that Purpose, ... Mr. Jack's and Mr. Alexander's 2*d* Scheme are the best and nearly the same.

Provost Smith then analyzed several of the procedures which had been suggested and indicated his preferences. He continued:

> . . . the whole Work will be no more this way than what appears on the enclosed Paper, which any Mathematician will tell you is exact & strictly demonstable.
>
> I lately saw Mr. Malcolm, the Mathematician & one of the Maryland Commissioners, & had a good Deal of Conversation with him at Annapolis. I believe the Preliminaries will be settled between him & me in Presence of the Commissioners. I find he is agreed with me in every Thing. He is an old Acquaintance of mine & a very reasonable as well as able man. . . . I must own that as my rank is [in] no way inferior to Mr. Malcolm's it would have given me Pleasure to have met him on an equal Footing, as much honoured by this Province as he is by his Province. One might have thought that as we had a Seminary of Learning here, it might have furnished at least one hand in running the Lines of two Provinces, & it might have been for the Honor of the Commission to have had one Person professing Mathematical Knowledge in it, as well as in that of the other Province. . . .

The commissioners for Maryland and for Pennsylvania met in their first joint session at New

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[1] Cope, T. D., and Robinson, H. W., When the Maryland-Pennsylvania boundary survey changed from a political and legal struggle into a scientific and technological project, *Proc. Amer. Philos. Soc.* **98** (6): 432–441, 1954.

[2] Correspondence of Gov. Sharpe (Archives of Maryland), **2**: 449–450.

[3] PMOC **9**: 143. Manuscripts preserved by the Historical Society of Pennsylvania are in PLB, Penn Letter Books; PMB, Penn Manuscripts, Boundaries; PMOC, Penn Manuscripts, Official Correspondence.

Castle on the Delaware on November 19, 1760, and remained in session until December 11. They agreed upon procedures to be followed in running the line which is now the major part of the western boundary of Delaware. The southern boundary of Delaware had been surveyed and marked in 1751. It is the eastern half of an "east-west" line from Fenwick Island to the eastern shore of Chesapeake Bay. The Middle Point of this transpeninsular line became the southwest corner of Delaware. From the Middle Point a line was to be run in the right direction to become tangent on its western side to the circle of radius twelve miles described about the court-house in New Castle as a center. At the conference of commissioners held in New Castle, as mentioned above, procedures for running the Tangent Line were agreed upon and surveyors were engaged to undertake the work. The Rev. Alex. Malcolm was too ill to attend the conference and the ideas of Provost William Smith failed to receive a hearing. But Provost Smith continued to be thought of as one who might help in the survey. Soon after his return to Annapolis from the conference in New Castle, Governor Sharpe wrote [4] on December 22 to Cecilius Calvert, an uncle of Frederick Lord Baltimore, who was then His Lordship's secretary. The Governor said:

> If the Gentlemen who may be consulted should be clearly of the Opinion that the best Method of finding the Point from which the North Boundary [of Maryland] must be run will be to take Observations, I believe it will be better for His Ldp & the Messrs Penns to have a good Instrument made in London at their joint Expence for the purpose & on its Arrival we can I believe get the Mathematical Master from Williamsburg to go up & together with Dr. Smith Provost of the Philaa Academy (whom I presume the Pennsylvania commissioners will engage) take such Observations as may be thought expedient.

The idea of Dr. William Smith's participation in the survey of the boundaries apparently had little appeal to Proprietor Thomas Penn, as occasional remarks in Mr. Penn's letters reveal. In a letter [5] to Governor Hamilton dated January 9, 1761, Mr. Penn remarks that commissioners are to be free "to proceed with the best Mathematical Advice they can get. . . ." In reference to the selection of commissioners, Mr. Penn suggests to Governor Hamilton,

> if you think proper Dr. Smith, who I find would not have been displeased to have been named. . . . I did not think he could have been spared from the Colledge. . . . I desire you will appoint such Persons, as you think the best qualified for the Business.

To Dr. Smith himself Mr. Penn said by letter [6] of Jan. 10,

> I return you my thanks for your Assistances to the Commissioners . . . but could not name you, as I conceived your presence at the College was necessary. I have desired the thoughts of Mr. Harris Mastr of the Mathematical School at Christ's Hospital on your proposition. . . .

Minutes of the conference of commissioners held at New Castle during the late autumn of 1760 had been sent to the proprietors. By March 13, 1761 Thomas Penn had received his copy and in a letter [7] of that date addressed to Governor Hamilton Mr. Penn remarked:

> I do not see by the Minutes that Dr. Smith's Scheme was offered and considered. . . . I leave it entirely to your judgment whether to appoint Dr. Smith a Commissioner or not, I think there may be some little danger of his being too much prejudiced in favour of his own Schemes, and tho' he may have a knowledge superior to John Watson and others, in the Theory of Surveying, he has not been accustomed to the practical part of it, and therefore perhaps as the best Scheme on paper may not be the most certain on Earth, his abilitys may not be so useful as others, tho' inferior.

The question of accepting Provost Smith's offer to serve as a commissioner for Pennsylvania remained in Thomas Penn's mind. By August, 1761, the Provost's Scheme and certain queries about the survey that he had raised had been reviewed by Mr. Penn's principal technological adviser, John Robertson, Head Master of the Royal [Naval] Academy at Portsmouth. In his letter [8] to Governor Hamilton of August 7 Mr. Penn said:

> I send you with this Mr. Robertson, Master of the Academy's Answers to Dr. Smith's Queries, and find by him he has no great opinion of the Doctor's Mathematical Abilitys, so that there cannot be any use in making him a Commissioner, or I believe consulting him in case of any difficulty.

When the year changed to 1762 the question of Dr. Smith was still on the mind of Thomas Penn.

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[4] Correspondence of Governor Sharpe (Archives of Maryland), **2**: 482.
[5] PLB **6**: 351–356.
[6] PLB **6**: 360–361.
[7] PLB **7**: 4–7.
[8] PLB **7**: 57.

In a letter[9] to Governor Hamilton dated Jan. 9, 1762 Mr. Penn wrote:

I am greatly pleased that you have prevailed with Mr. Coleman to be one of the Commissioners, and that Mr. Holt has quitted it so handsomely . . . you will do as you think proper with regard to Dr. Smith but I join with you in opinion that Mr. Coleman is much to be preferred. . . . I fear Dr. Smith's Mathematics are rather superficial as he does not allow himself time to enter seriously into the consideration of Business before he engages in it. . . .

And one month later Mr. Penn wrote to Dr. Smith a long and friendly letter[10] about affairs in general including some of the problems of the survey. Penn and Smith continued to be friends and to exchange letters. And the Provost could not forget his ambition to serve the Province as a commissioner, for he was unhappy when not in the public eye. Three years later, on Feb. 15, 1765, Thomas Penn was moved to say to Dr. Smith in reply[11] to a communication from him:

I am very sensible of the services you have done with regard to the Commission for running the Lines, but I should never have consented to have had you taken from the College for any such service, I think you should not be employed in any service that should oblige you to be absent from it, and therefore in case there should be any other wanting cannot think of desiring your assistance—The mathematical part of these Lines we leave to the Surveyors, and therefore the Gentlemen that are appointed Commissioners have the less occasion to be Mathematicians. I return you my thanks however for your readiness to assist us in that Affair. I am sorry your not having been appointed should have been injurious to you, but it cannot have been seriously supposed to proceed from either of the Causes you mention.

The letter which Provost William Smith wrote[3] to Thomas Penn on Oct. 22, 1760, conveys two principal messages, the first of which is that the Provost had reviewed all schemes for running the Tangent Line that had been proposed to the commissioners for Pennsylvania and was offering in their stead "on the enclosed Paper" a simpler and better scheme of his own. The second message advised Proprietor Penn to appoint William Smith one of his commissioners. The scheme "on the enclosed Paper" was in all probability the one which Mr. Penn referred[6] to Daniel Harris, Master of the Mathematical School at Christ's Hospital, for comment.

[9] PLB **7**: 96.
[10] PLB **7**: 105–106.
[11] PLB **8**: 222–224.

And the scheme "on the enclosed Paper" received many comments in the correspondence of Thomas Penn which enable one to recognize it. There is hardly a doubt that it is the scheme preserved in copy by the Historical Society of Pennsylvania under the title, "Dr. Smith's Scheme for running the Tangent Line—Coppy."[12] When one reads the "Scheme" today, almost two-hundred years after 1760, one sees in it many sound ideas that were soon put to use. It was a simple scheme—on paper at least. But running the Tangent Line kept the provincial surveyors at work through 1761, 1762, and well through 1763, with no final success in sight. Mason and Dixon finally took it over in June, 1764, worked on it continuously and brought it to completion during the following November. More was needed to survey the Tangent Line than Provost William Smith's academic knowledge of geometry.

In their excellent, comprehensive bibliography entitled "Manuscripts and Publications relating to the Mason and Dixon Line . . ."[13] the late Edward L. Burchard and the late Edward B. Mathews list "Dr. Smith's Scheme" as follows:

1761, Feb. Demonstration by Dr. Robert Smith
"Scheme for running the tangent lines". 2pp. fol. with diag. Ms. Copy. Pa. Hist. Soc., Penn. Mss. "Boundaries", p. 94. Note. Dr. Smith was professor of astronomy and Vice Chancellor of Cambridge Univ. and founder of its Smith mathematical prizes.

Thomas Penn mentioned his advisers freely in his letters. No mention of Professor Robert Smith has been found in his correspondence. The original of the exhibit in folder 94 of Penn. Mss. Boundaries was mailed on October 22, 1760, by Provost William Smith and all discussion of it was made in letters to him or in references to him in other letters.

And Provost William Smith appears to have taken part in the discussion of how to run a parallel of latitude in preparation for the survey of the boundary line between Maryland and Pennsylvania. His contribution is contained in eight queries which are preserved by the Historical Society of Pennsylvania in its Penn Manuscripts, Boundaries, folders 68 and 81. They are entitled "Queries, On the 2^{d} 4th & 8th of the Original

[12] PMB, folder 94.
[13] Published as part IV of the Report on the Resurvey of the Maryland-Pennsylvania Boundary, Maryland Geological Survey, **7**, Baltimore, 1908; Penna. Dept. Internal Affairs, Harrisburg, 1909.

Articles between the proprietors of Maryland and Pennsylvania." Folder 81 contains only the queries; folder 68 includes also John Robertson's answers dated July 6, 1761, and an essay of the same date by Robertson on running a parallel of latitude. Letters[14] written during the spring, summer, and autumn of 1761 identify the "Queries" with "Dr. Smith." Thomas Penn to Governor Hamilton on April 13 says:

> Shall send you answers to the several queries made by Dr. Smith on the best method of running a parallel of Latitude, having laid them before Mr. Simpson of the [Military] Academy at Woolwich.

An equivalent statement appears in a letter to Secretary Peters of the same date. On April 28, 1761 Thomas Penn says in a letter to John Robertson

> . . . there is to be a West Line run . . . which is to be a parallel of Latitude, and I have received some Queries relating to it, which I am desired by my Commissioners to get answers to, from some able Mathematician; these I enclose to you. . . .

A few days later, on May 9, Mr. Penn tells Provincial Secretary Richard Peters that

> Mr. Simpson the Master of the Academy at Woolwich being in the North of England and to stay there a very long time, [He was ill and soon died] I have sent the Queries to Mr. Robertson Master of the [Naval] Academy at Portsmouth. . . .

On August 7 Mr. Penn wrote to Governor Hamilton

> I send you with this Mr. Robertson, Master of the Academy's Answers to Dr. Smith's Queries, and find by him he has no great opinion of the Doctor's Mathematical Abilitys. . . .

To Secretary Peters Mr. Penn added on August 8,

> I send you enclosed Mr. Robertson's answers to the Queries made by Dr. Smith. . . . Mr. Robertson has added to the Answers a Scheme for running the Parallel of Latitude, and I have some of the Instruments making here for it, . . .

And to his commissioners Mr. Penn wrote on October 9, 1761:

> We sent by the last Packet to Mr. Hamilton, a copy of Mr. Robertson's answers to the Queries proposed by Dr. Smith, . . . I send with this another Copy of these Answers, and also a Copy of some observations made upon it by a very ingenious gentleman [Dr. John Bevis], on whom Lord Baltimore much relys, for yours & your Mathematicians consideration, both these I propose to shew to Mr. Daval, who is now at Bath. . . .

Two suggestions made by Provost Smith in his letter[3] to Thomas Penn of October 22, 1760, appealed to the administrators of Pennsylvania and brought results, *viz.* that Philadelphia's "Seminary of Learning furnish at least one hand in running the Lines" and that the commission representing Pennsylvania have in it "one Person professing Mathematical Knowledge." Both suggestions were put into effect on July 23, 1762, when Governor James Hamilton appointed the Rev. John Ewing a member of his commission.

The Rev. John Ewing, a native of Cecil County, Maryland, was just thirty years of age in 1762. He had been educated in the Rev. Francis Alison's academy at New London, Pennsylvania, and at the College of New Jersey, from which he had won his bachelor's degree in 1755. He had then studied theology with Dr. Alison and had been licensed to preach by the presbytery of New Castle. His major interest in school and college had been mathematics. He had been an assistant teacher in the New London Academy and in the grammar school associated with the college in Princeton. During the winter of 1758–59, while Provost Smith was on a journey to England, the Rev. John Ewing had conducted the philosophical classes in the College of Philadelphia. And during the year 1759 the Rev. John Ewing had received and had accepted a call to the pastorate of the First Presbyterian Church of Philadelphia. When Thomas Penn learned that John Ewing had been appointed to the commission which was conducting the survey of the boundary lines he expressed his warm approval by letter[15] of December 10, 1762, to Governor Hamilton.

By midsummer of 1762 it had become evident to all involved that the provincial surveyors were having a considerable struggle with the Tangent Line which they were instructed to lay off from the Middle Point to touch the circle of twelve miles radius about the court-house in New Castle on its western side. Their instructions were to run a measured arc of meridian northwards from the Middle Point until the court-house was in sight, then to run a line to the court-house measuring its length and bearing. From the data obtained, the bearing of the Tangent Line and the position of the Tangent Point were to be calculated. The Tangent Point was to be marked by

[14] All in PLB 7.

[15] PLB 7: 224–227.

posts set in the ground, and the Tangent Line was to be run at the bearing calculated from the Middle Point until it passed near the posts set to mark the Tangent Point. The surveyors had worked from early spring until late autumn in 1761, and had been working since early spring in 1762. In fact they continued until late autumn of 1762 and again from early spring of 1763 until early autumn of that year without achieving an acceptable Tangent Line.

By midsummer of 1762 when Governor Hamilton brought the Rev. John Ewing into the survey both the Pennsylvanians and the Marylanders were thinking of securing talent from England to take charge of the survey. Thomas Penn had let it be known that at John Robertson's advice he was having a zenith-sector built for running the Maryland-Pennsylvania boundary. By letter[16] of August 14 Mr. Penn told Governor Hamilton, "I propose to send in conjunction with Lord Baltimore, one or two Persons with our Sector to take observations, if his Lordship will agree to it." And a later letter[17] of Mr. Penn's makes it clear that he had Mason and Dixon in mind in August, 1762. By letter[18] of September 25, Governor Horatio Sharpe of Maryland appealed to Lord Baltimore to find in England "a gentleman of mathematical ability and integrity . . . to come hither to direct and superintend the work." Communications were slow in those days and Lord Baltimore was most of the time somewhere along the Mediterranean. Not until July, 1763 did he finally agree to Thomas Penn's proposal that they jointly send Mason and Dixon to America. News of that decision reached Maryland and Pennsylvania late in the summer. In the meantime the provincial surveyors had continued their work on the Tangent Line.

When it was finally certain that the proprietors of both provinces were jointly sending Mason and Dixon to do the surveying the commissioners in both Pennsylvania and Maryland set about to prepare summaries and appraisals of what had been accomplished during 1761, 1762, and 1763. Letters[19] were written to Thomas and Richard Penn by their commissioners on September 30 and on December 20, 1763, which present in considerable detail what had been accomplished on the Tangent Line.

[16] PLB **7**: 182–183.
[17] PLB **7**: 292–293.
[18] Correspondence of Governor Sharpe (Archives of Maryland), **3**: 71–75.
[19] PMOC **9**: 201–202; PMB, folder 115.

The later letter enclosed two exhibits[20] which the Rev. John Ewing had prepared entitled "A Representation of Facts, and a Draught delineating the Two Lines last run."

In his reply[21] to the commissioners dated April 13, 1764, Thomas Penn acknowledged receipt of both letters and said that he had conferred with Cecilius Calvert, Lord Baltimore's secretary, and with Dr. Bevis, who had studied Ewing's reports, and with Mr. Harris. He reported that the Maryland commissioners had submitted a report similar to Mr. Ewing's prepared for them by one of their number, the Rev. John Barclay, a mathematician. All were agreed, said Mr. Penn, that regardless of expense, the Tangent Line should be run again by Mason and Dixon using their transit instrument, which they had just brought to America. It had been built for Mr. Penn by John Bird, the foremost instrument maker of the time.[22] And during a series of joint meetings held in Philadelphia during the previous November and December, on December 9 the commissioners of both provinces had instructed Mason and Dixon to the same effect. They were to undertake the Tangent Line on June 15, 1764, and were to be guided by the Hints prepared jointly by Dr. Bevis and Mr. Harris. The Hints had been commended to both boards of commissioners by Cecilius Calvert and by Thomas and Richard Penn.

Mason and Dixon began work on the Tangent Line on June 13 and remained with it until late autumn. Their last record of work on it was made on November 13. It reads:[23]

> From the data of August 27th we computed how far the true Tangent Line would be distant from the Post (shewn us to be the Tangent Point) and found it would not pass one inch to the Westward or Eastward.
>
> On measuring the angle of our last line, with the direction from Newcastle, it was so near a right angle that, on a mean from our Lines, the above mentioned Post is the true Tangent Point.
>
> From the whole we conclude, that the Offset Posts in our last Visto, mark'd MD, are (as near as is practicable) in the true Tangent Line.

Mason and Dixon had the advantages of the bitter experience of their predecessors, of their own training, equipment, and wide experience,[24] and

[20] PMB, folders 97 and 92.
[21] PLB **8**: 54–55.
[22] John Bird, *Dictionary of National Biography*.
[23] Charles Mason's Daily Journal, 1763–1768.
[24] Articles by H. W. Robinson and T. D. Cope in *Library Bulletins* of American Philosophical Society, annually from 1948 to date.

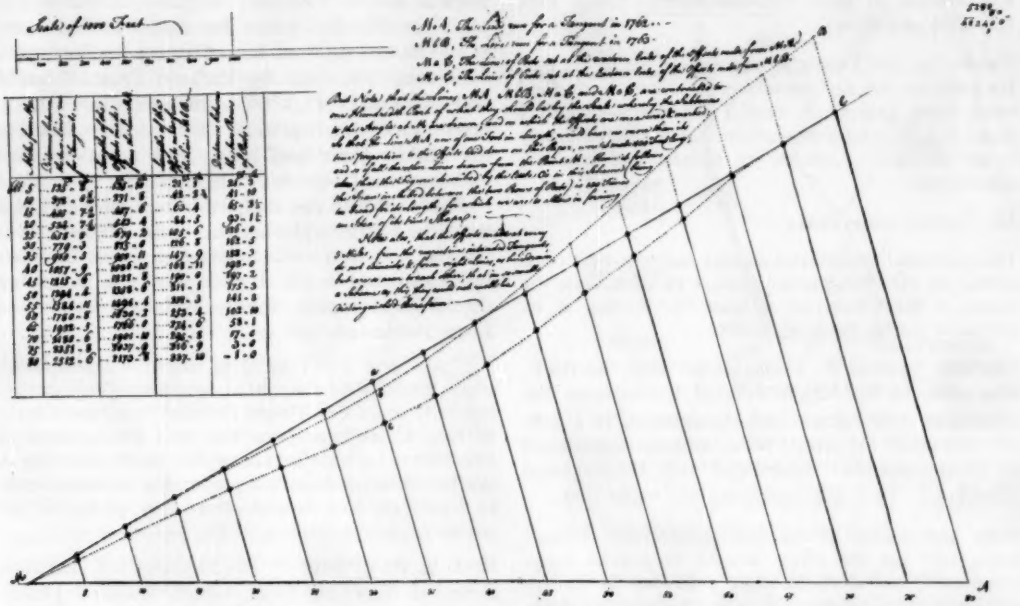

FIG. 1. Courtesy of the Historical Society of Pennsylvania.

of accurate, speedy astronomical methods. And they were never impeded by such political and personal wrangles as had repeatedly retarded the work of the provincials.

The Rev. John Ewing served as a commissioner from the date of his appointment until the survey was completed. He was one of the twelve commissioners who on November 9, 1768, signed the map of the boundaries that Mason and Dixon had prepared from their records. Perhaps the impression made by John Ewing upon those with whom he worked during this period may be inferred from an appeal that came to him. In the summer of 1786 Charles Mason with wife and children left England and migrated to Philadelphia. There he became seriously ill and was not recovering. Since leaving Philadelphia in 1768 Mason had worked in England under the direction of Astronomer Royal Maskelyne for the Commissioners of Longitude in preparing the annual issues of the *Nautical Almanac* and in revising Mayer's *Lunar Tables*. In 1786 one revision of the *Tables* was ready for publication. Mason was ambitious to further improve the *Tables* and had brought his manuscripts to America. During his last illness Mason handed his materials to the Rev. John Ewing with the appeal that he carry the work to completion.[25] In the autumn of 1786 Ewing was serving as professor of natural philosophy and provost of the University of the State of Pennsylvania.

As a specimen of the Rev. John Ewing's early work as a commissioner for Pennsylvania there is reproduced as figure 1 his "Draught delineating the Two Lines last run" which summarized his essay entitled "a Representation of Facts." Essay and Draught were sent by the Pennsylvania Commissioners to Thomas and Richard Penn as enclosures with their letter [19] of December 20, 1763.

A tradition still survives that David Rittenhouse made an important contribution to the survey of the boundaries just before the arrival of Mason and Dixon in the autumn of 1763. The story [26] is told in the "Memoirs of Rittenhouse" written by his nephew, William Barton Esq., of Lancaster, Pennsylvania, a son of the Rev. Thomas Barton and his wife who was a sister of Rittenhouse. The memoirs were published just fifty years after 1763. Mr. Barton quotes a letter by

[25] Cope, T. D., and H. W. Robinson, The astronomical manuscripts which Charles Mason gave to Provost the Reverend John Ewing during October 1786, *Proc. Amer. Philos. Society* **96** (4) : 417–423, 1952.

[26] Memoirs of Rittenhouse, 145–150.

Rittenhouse to Rev. Thomas Barton dated Feb. 16, 1764 as follows:

> I waited on Mr. Peters, as you desired me to do. . . . He paid me for my attendance at New Castle, and much more generously than I expected;—though I found it a very laborious affair; being obliged singly to go through a number of tedious and intricate calculations.

Mr. Barton comments:

> The particular department of that business thus committed to Mr. Rittenhouse, seems to have been the fixing of the Circle—or at least, the tracing of its course or route, topographically;

The late Samuel W. Pennypacker kept the tradition alive in his article "David Rittenhouse the American Astronomer" which appeared in *Harper's Monthly* for May, 1882, and is republished in Pennypacker's "Historical and Biographical Sketches." In it the assertions are made that,

> With instruments of his own manufacture Rittenhouse laid out the circle around Newcastle topographically, and alone he made a number of tedious and intricate calculations in such a satisfactory manner that he was tendered extra compensation. . . . Mason and Dixon . . . accepted Rittenhouse's circle without change. . . .

It may be pertinent to point out that only a short arc of the circumference of the Circle, the mile and a half of arc just north of the Tangent Point, was a boundary between Baltimore and the Penns. The rest of the circumference was a boundary only along the arc that separated New Castle county from Chester county, which in those days included Delaware County. New Castle and Chester counties were both Penn territory and their line of separation was of no concern to Lord Baltimore, his officials, commissioners and surveyors, or to Mason and Dixon.

No mention of David Rittenhouse has been found in the Minutes of the Commissioners for Maryland and Pennsylvania from 1760 to 1768, in the Journal of Charles Mason, or anywhere in the records of that period, except in the record of the disbursements[27] made by Richard Peters, who was Provincial Secretary, a commissioner for Pennsylvania, and (until Joseph Shippen, Jr., succeeded him) disbursing officer who paid the bills of the survey for the Penns. No record of payments to Rittenhouse by Joseph Shippen, Jr., has been found.[28] The only mention of David Rittenhouse that this writer has found in the record of the Baltimore-Penn boundary survey during the 1760's is that made by Richard Peters[27] under date of January 30, 1764, to the effect that Rittenhouse was paid 6 pounds "for his attendance at the Middle Point and New Castle to take observation of the Latitudes."

For what uses did Richard Peters wish to know those latitudes? During the early 1760's it was "in the air" that reliable determinations of those latitudes could be put to good use. On December 20, 1760, Governor Sharpe said in a letter[29] to Lord Baltimore:

> . . . An error that may arise from the Mensuration might possibly be discovered by taking Observations carefully at the two Points [Middle Point and Center of New Castle] for I am told that the Latitude of two Points on the Surface of the Earth might by a skillful Observer & with a proper & good Instrument be determined to a Second, which is equal to 102 feet measured on the Surface of the Earth.

And in their letter[30] to Thomas and Richard Penn of May 10, 1762, which Richard Peters joined his fellows in signing, the Commissioners for Pennsylvania united in saying:

> Before we set out for Newcastle the Jersey Quadrant[31] was brought hither from New York. . . . It would have given us some satisfaction to have known by the means of good Observation taken with such an Instrument the true Latitude of the Beginning and End of the Meridian Line, which has been run from the Middle Point and measured (as we believe) with a good deal of care; there having never yet, that we have heard of, been any attempt to determine the measure of a Degree of Latitude on the Earth's surface in North America. We should be the better pleased with an opportunity of determining this matter as we imagine it may come in Question in some of our future Operations respecting the West Line [Parallel]. When that Line comes to be run this Quadrant, or some other of equal goodness will, we conceive be necessary. . . .

In a letter[32] of advice on how to run the Tangent Line written by Daniel Harris from Christ's Hospital on February 27, 1761, the first move sug-

[27] Original Vouchers in Library of the American Philosophical Society.

[28] Records of Joseph Shippen, Jr., held by American Philosophical Society and by Historical Society of Pennsylvania.

[29] Correspondence of Governor Sharpe (Archives of Maryland), **2**: 468–473.

[30] PMOC **9**: 170.

[31] Cope, T. D., The Jersey Quadrant used in Pennsylvania, *Proc. Amer. Philos. Soc.* **97** (5): 565–570, 1953.

[32] PMB, folder 66.

gested is the finding of the difference of latitude between New Castle and the Middle Point.

From these quotations it is clear that both the Maryland and the Pennsylvania contingents had numerous reasons for wishing to know the two latitudes. The writer believes that their determination was the only occasion for the visit of Rittenhouse to the Middle Point and New Castle for which Secretary Peters paid him early in 1764.

About the story of Rittenhouse's "laying out the circle topographically" the writer continues to be highly skeptical. Mr. William Barton's original account was a surmise; Mr. Pennypacker's account is obviously an embellished revision of Barton's original. The circle around New Castle was first blazed by Taylor and Pierson in 1701. It was finally surveyed, adjusted, and marked for Delaware and Pennsylvania by engineers of the U. S. Coast and Geodetic Survey in 1892–93. An extended report on the history of the circular boundary and on the resurvey is published as appendix 8 to part 2 of the Superintendent of the Survey's Report for 1893. No mention is made in it of Rittenhouse's running of the circular boundary at any time.

As to the acceptance of Rittenhouse's circle without change by Mason and Dixon the following is to be said. The only arc of the circle that concerned Mason and Dixon was the mile and a half of arc which extends from the Tangent Point northwards. It alone of the whole circumference around New Castle is a boundary between former Penn and Baltimore territories. Mason and Dixon surveyed and marked this arc during June, 1765, with no acknowledgments to anyone.[33]

To bring out roughly the relative positions of Fenwick Island, the Middle Point, the Tangent Line, the Tangent Point, and New Castle there is inserted as figure 2 a line drawing. In it the Circle is much exaggerated to bring out the arc which is a part of the Delaware-Maryland boundary. This arc is the only part of the entire circumference that Mason and Dixon surveyed and marked.

It would be interesting to learn what "proper and good instrument" Rittenhouse used in making his "observation of the Latitudes" of the Middle Point and of New Castle. In an earlier article[31] the writer has given his reasons for thinking that

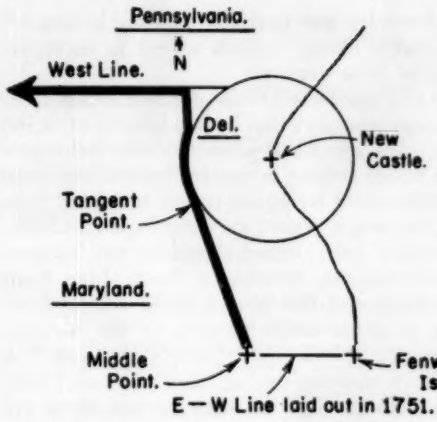

FIG. 2. This sketch is not drawn to scale; the circle is much exaggerated. The boundaries which were surveyed and marked during the 1760's ran from Middle Point to Tangent Point, thence around the arc and along the meridian to N, thence due westward to the Monongahela River and beyond it.

the Jersey Quadrant may have been used. It had been borrowed in 1762 for use on the boundaries.

The length of a degree of latitude in Maryland and Pennsylvania was measured by Mason and Dixon during their stay in America. The project was sponsored and financed by the Royal Society of London at whose request Astronomer Royal Maskelyne directed the work by correspondence. Equipment was in part borrowed from the proprietors and in part sent by the Society. Full accounts of work on the project are given in Mason's Daily Journal.[33] The work was reported to the Society late in 1768 after Mason and Dixon had returned to London. Papers by the Astronomer Royal and by Mason and Dixon appear in *Philosophical Transactions*.[34]

Mentions of other advisers to the Penns and their commissioners have been found in the records. Provost Smith spoke of "Mr. Jack's and Mr. Alexander's 2[d] Scheme as the best & nearly the same." William Parsons writing[35] on March 28, 1752 comments upon Mr. Jack's ideas on the way to lay out the circle about New Castle. Mr. Peters, writing[36] during early years of the survey, perhaps before 1760, discusses a scheme of running the lines by magnetic compass and refers to Mr. Alexander's tables showing Variation of Variation contrived for use with this scheme.

[33] Charles Mason's Daily Journal (1763–1768), records June 1–18, 1765. Original in National Archives, Washington, D. C., photographic reproductions in Library of American Philosophical Society.

[34] *Phil. Trans.* **58**, papers 41–43, 1768.

[35] *Pa. Arch.*, ser. 2, **7**: 240.

[36] PMB, folder 101.

Mr. Alexander was probably James Alexander [37] or his son William.[37] Each served as surveyor-general of New Jersey.[38]

There is on record [39] an undated letter from Mr. Grew, who says that he was employed in the survey. He sets forth principles and techniques that he would employ in running each of the lines. He advises about laying out the circle around New Castle, running a West Line from Cape Henlopen, or Phenin's [*sic*] Island, running the Tangent Line by compass, running a South Line from Philadelphia, and the West Line by offsets from an arc of great circle tangent to the parallel. Perhaps Mr. Grew was Theophilus Grew [38] a well-known schoolmaster of Maryland and Philadelphia. Not enough has been learned about the proposals of these three men to permit a fair appraisal of their significance.

The governor and commissioners of Maryland were advised by a group of able men who must be considered in a separate paper. The names of Hugh Jones, William Rumsey, Lewis Evans, Rev. John Barclay, Professor Graham, Rev. Alex. Malcolm, and John Leeds have been met in the records.

The effectives among the counsellors were John Robertson and Daniel Harris who advised Thomas Penn. Lord Baltimore and Cecilius Calvert took advice from Dr. John Bevis. And in the end Dr. Bevis and Mr. Harris together drew up the "Hints" which the proprietors together entrusted to Mason and Dixon for delivery to Governor Hamilton and Governor Sharpe with strong recommendations that these "Hints" be given serious consideration.

When the survey of their common boundaries loomed before the Baltimores and the Penns as a common responsibility that must be met they received from advisers, both those invited to serve and volunteers, an array of suggestions as to how to lay out the lines. Over a period of years these suggestions were reviewed and amended, some discarded, some retained. A principal outcome was the "Hints" of Dr. Bevis and Mr. Harris. The phenomenon of able minds grappling with a problem and finally mastering it invites further study.

[37] *Dictionary of American Biography.*
[38] Cope, *op. cit.*
[39] PMB, folder 99.

RACIAL BLOOD PRESSURE STUDIES: A CRITIQUE OF METHODOLOGY

With Especial Reference to the Effect of Age, Nutrition, Climate, and Race on Blood Pressure in Puerto Rico

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INTRODUCTION

THIS study is fundamentally concerned with the following question. Are there actual racial differences in blood pressure, or are the observed differences due to lack of control of such variables as age, nutrition or climate?

If one reviews the existing literature on racial blood pressure studies, it is at present impossible to answer correctly the above question, for the simple reason that the methodology used in these studies is so unscientific that many undoubtedly erroneous conclusions have been and are being reached concerning possible racial blood pressure differences.

It is, therefore, the purpose of this study to devise a methodology whereby one can answer the above question, at least as far as Puerto Rico is concerned, and perhaps to lead the way methodologically for future racial blood pressure studies.

In order to evaluate correctly existing racial blood pressure studies, from the point of view of methodology, it will first be necessary to examine a representative sample of a particular population, in this case the population of Puerto Rico.

The necessity for first examining a truly representative sample of a large population, regarding blood pressure, is quite simple. First, until this study, such a representative sample has not been obtained. Second, only from such a sample can one design the proper experiments by which to test the importance of different variables possibly affecting blood pressure.

SCOPE

This study is not concerned specifically with hypertension, arteriosclerosis, or arteriolosclerosis. It is divided into four parts.

Part I is concerned with the methodology involved in discerning the most important variables affecting blood pressure, based on a representative male and female Puerto Rican sample. This part will indicate the range of normal blood pressure of the 1948 Puerto Rican population, particularly ages 20–49, taking into consideration such variables as sex, age, weight groups, etc. It will be shown here that the most important variables affecting blood pressure are weight groups and possibly age in relation to weight groups, and that the following variables exert no appreciable effect on blood pressure: body build, urban or rural life, nutritional class, climate of two main Puerto Rican regions, and intestinal parasitic infestation.

Part II is concerned with a critique of the methodology used in existent racial blood pressure studies. Here general examples of the methodology used in such studies will be indicated, and an efficient methodology will be proposed, wherein it will be shown that important variables possibly affecting blood pressure must be controlled.

In Part III the methodology proposed in Part II will be used on a specific Puerto Rican negro and white sample. Given the control of a number of important variables possibly affecting blood pressure, it will be shown that neither the systolic nor diastolic blood pressure difference between the negro and white samples is significant.

Part IV consists of a general summary and conclusions.

BACKGROUND AND ACKNOWLEDGMENTS

The Puerto Rican portion of this study is part of a larger human biological study, in which the author participated, made between June, 1948, and February, 1949, of the adult Puerto Rican population. The larger study included twenty-six anthropometric measurements, a dental analysis, blood typing, and several other physiological evaluations including blood pressure.

The Puerto Rican project was originally conceived mainly by Professor Harry Shapiro of Columbia University and the American Museum of Natural History, who proposed to the Social Science Research Center of the University of Puerto Rico that a combined human biological and cultural investigation should be followed. Professor Julian Steward, at that time of Columbia University, was invited to take charge of the cultural aspect of the project, mainly community studies, by Professor Shapiro who subsequently directed the human biological aspect. Thus the whole project was eventually the result of the combined efforts of the Social Science Research Center of the University of Puerto Rico, the American Museum of Natural History, and the Department of Anthropology of Columbia University.

Concerning the human biological aspect of the project it was also Professor Shapiro who suggested that the Puerto Rican population be sampled in a structured fashion. The results of this suggestion are described in detail in Part I of this study under the heading "Sample Structure."

In addition to Professors Shapiro and Steward, the author wishes to thank the many individuals in Puerto Rico who aided the project in countless ways, and without whose aid the project would never have been completed. In particular the author would like to thank Dr. Pons, Director of the Department of Public Health, Dr. Morales Otero of the School of Tropical Medicine, Dr. Janer, Chief of the Bureau of Registry and Vital Statistics, Dr. Rotenberg, formerly Head of the Social Science Research Center, Dr. Lydia Rob-

erts of the Department of Nutrition of the University of Puerto Rico, and last but not least the doctors who were in charge of the various public health centers or hospitals where individuals were obtained for the Puerto Rican sample.

Grateful thanks are also due to the Directors of the Watson Scientific Computing Laboratory of the International Business Machines Corporation near Columbia University, who made available to the project the necessary IBM machines for the statistical analysis of the Puerto Rican data.

Finally, the author is greatly indebted to the Wenner-Gren Foundation for Anthropological Research for a pre-doctoral fellowship, without which the Puerto Rican analysis would not have been possible.

PART I. METHODOLOGY INVOLVED IN DISCERNING THE MOST IMPORTANT VARIABLES AFFECTING BLOOD PRESSURE

PUERTO RICO

Puerto Rico is an island which lies east of Santo Domingo in the West Indies. It is roughly rectangular in shape, approximately 113 miles long, and averages 45 miles in width.

Puerto Rico has a mountainous backbone, rising 4,000 feet in height, running from west to east in the central part of the island. From the point of view of climate Puerto Rico may be divided into seven main regions each containing a varying number of municipios or municipalities.

These regions correspond to the seven regions of the 1940 Census of Population and Housing. The regions are doubtless an oversimplification of existing climatic and ecological zones but are sufficiently distinctive for the purposes of this study. The regions are shown in figure 1 and are as follows: (1) Northwestern Coast. Arid. (2) North Central Coast. Subhumid to humid. (3) Eastern Coast. Humid. (4) Southern Coast. Semi-arid to very arid. (5) Western Coast. Wet summer and dry winter. (6) Western Mountainous Interior. Rainy and humid. (7) Eastern Mountainous Interior. Humid.

Coffee is grown in region 6 and tobacco in region 7. Sugar cane is grown predominantly in regions 1–5. However, the most diversified agriculture is to be found in regions 1 and 2, for here one encounters in addition to sugar cane, cotton and tobacco in the northwest; coconut, grapefruit, and pineapple plantations east of Arecibo; and the best organized dairy district near San Juan and Rio Piedras. Furthermore, San Juan is the largest urban area in the island with the most important commercial and manufacturing enterprises.

The mean temperature for the whole island is 73° F. in winter and 79° F. in summer, with an average of 76.6° F. The average annual rainfall is 72.6 inches, the lowest readings being in region 4 and the highest in region 6 and the municipio of Luquillo. The average annual hours of sun-

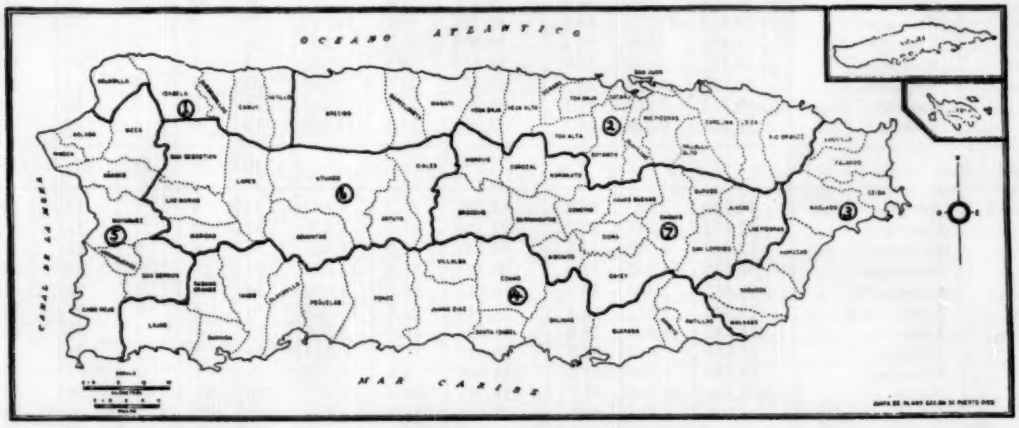

FIG. 1. Puerto Rico. Regions: (1) Northwestern Coast; (2) North Central Coast; (3) Eastern Coast; (4) Southern Coast; (5) Western Coast; (6) Western Interior; (7) Eastern Interior.

TABLE 1

SAMPLE STRUCTURE

Region	Municipio	1940 Total pop'n	1940 Pop'n 20–44	1940 20–44 %	1948 Total pop'n	1948 Pop'n % urban	1948 Pop'n 20–44	Total	Sample			
									Urban		Rural	
									M	F	M	F
A	B	C	D	E	F	G	H	I	J	K	L	M
1	Aguadilla	34,956	12,643	36.1	42,004	42.6	15,193	103	22	22	29	30
	Camuy	18,922	6,161	32.5	21,513	13.5	7,005	47	3	3	20	21
	Hatillo	18,322	5,910	32.2	20,276	15.2	6,535	44	3	3	19	19
	Isabela	25,842	8,291	32.0	26,670	17.3	8,556	57	4	5	24	24
	Quebradillas	11,494	3,732	32.4	12,545	12.9	4,073	27	1	2	12	12
								278	33	35	104	106
2	Arecibo	69,192	24,390	35.2	80,957	45.6	28,537	192	44	44	52	52
	Barceloneta	18,545	6,175	33.3	20,768	9.5	6,916	46	2	2	21	21
	Bayamon	37,190	12,463	33.5	46,783	34.1	15,677	105	18	18	34	35
	Carolina	24,046	7,724	32.1	29,200	19.3	9,379	63	6	6	25	26
	Catano	9,719	3,535	36.3	12,392	80.5	4,507	30	11	11	4	4
	Dorado	9,481	3,128	32.9	11,038	18.0	3,641	24	2	2	10	10
	Guaynabo	18,319	6,246	34.1	24,222	4.2	8,260	55	1	1	26	27
	Loiza	22,145	7,115	32.1	24,430	35.3	7,849	53	9	10	17	17
	Manati	29,366	9,501	32.3	32,587	13.0	10,542	71	4	5	31	31
	Rio Grande	16,116	5,126	31.8	16,800	15.5	5,344	36	3	2	15	16
	Rio Piedras	68,290	26,374	38.6	99,026	57.1	38,244	257	73	74	54	56
	San Juan	169,247	69,543	41.0	230,231	100.0	94,601	635	315	320	—	—
	Toa Alta	13,371	4,138	30.9	14,075	7.2	4,356	29	1	1	13	14
	Toa Baja	11,410	3,880	34.0	13,787	17.3	4,689	32	2	3	14	13
	Trujillo Alto	11,726	3,595	30.6	13,747	7.0	4,215	28	1	1	13	13
	Vega Alta	14,329	4,381	30.5	15,978	20.8	4,884	33	3	4	13	13
	Vega Baja	23,105	7,441	32.2	23,358	29.4	7,524	51	7	8	18	18
								1,740	502	512	360	366
3	Ceiba	7,021	2,186	31.1	5,523	19.7	1,720	12	1	1	5	5
	Culebra	860	229	26.6	738	—	197	—				
	Fajardo	20,405	7,044	34.5	24,324	34.8	8,397	56	10	10	18	18
	Humacao	29,833	10,731	35.9	32,220	19.0	11,590	78	8	7	31	32
	Luquillo	8,851	2,787	31.4	10,009	21.7	3,152	21	3	2	8	8
	Maunabo	10,792	3,444	31.9	11,548	9.4	3,685	25	1	1	12	11
	Naguabo	19,180	6,376	33.2	17,352	24.9	5,768	39	5	5	15	14
	Vieques	10,362	3,266	31.5	10,981	22.0	3,461	24	2	3	10	9
	Yabucoa	27,438	9,256	33.7	33,100	15.8	11,165	75	6	6	32	31
								330	36	35	131	128
4	Arroyo	10,746	3,855	35.8	13,609	29.3	4,882	33	5	5	12	11
	Coamo	22,772	7,567	33.2	25,340	42.2	8,420	57	12	12	17	16
	Guanica	12,685	4,292	33.8	14,739	32.0	4,988	34	6	5	11	12
	Guayama	30,511	11,437	37.4	36,123	51.2	13,539	91	24	23	22	22
	Guayanilla	15,577	5,460	35.0	16,941	16.5	5,938	40	4	3	16	17
	Juana Diaz	23,396	8,512	36.3	28,540	21.8	10,383	70	8	7	27	28
	Lajas	14,736	4,844	32.8	16,883	19.0	5,549	37	4	3	15	15
	Patillas	17,319	5,669	32.7	20,358	11.2	6,663	45	3	2	20	20
	Penuelas	14,789	4,880	33.0	15,608	9.8	5,151	35	1	2	17	15
	Ponce	105,116	39,705	37.7	119,087	61.6	44,979	298	91	93	59	55
	Sabana Grande	14,146	4,746	33.5	17,105	35.3	5,739	39	7	7	13	12
	Salinas	19,400	7,278	37.5	21,599	55.0	8,104	54	15	15	12	12
	Santa Isabel	11,468	4,499	39.2	13,889	20.9	5,449	37	4	4	15	14
	Villalba	12,871	4,103	31.8	12,878	41.0	4,106	28	6	5	8	9
	Yauco	30,533	10,389	34.0	31,329	34.8	10,661	72	13	12	23	24
								970	203	198	287	282

TABLE 1—*Continued*

Region	Municipio	1940 Total pop'n	1940 Pop'n 20–44	1940 20–44 %	1948 Total pop'n	1948 Pop'n % urban	1948 Pop'n 20–44	Total	Sample			
									Urban		Rural	
									M	F	M	F
A	B	C	D	E	F	G	H	I	J	K	L	M
5	Aguada	17,923	5,957	33.2	20,129	11.9	6,691	45	2	3	20	20
	Anasco	15,701	5,235	33.3	16,030	23.3	5,344	36	4	4	14	14
	Cabo Rojo	28,586	9,081	31.7	33,398	19.3	10,611	71	7	7	28	29
	Hormigueros	6,098	2,153	35.3	6,856	35.2	2,421	16	3	3	5	5
	Mayaguez	76,487	28,169	36.8	89,494	67.9	32,961	222	75	76	36	35
	Moca	19,716	6,378	32.3	19,235	19.7	6,222	42	4	4	17	17
	Rincon	9,256	2,852	30.8	10,977	17.8	3,382	23	2	2	9	10
	San German	26,473	9,253	34.9	28,757	23.5	10,051	67	8	8	25	26
								522	105	107	154	145
6	Adjuntas	22,556	7,479	33.1	28,354	21.9	9,402	63	7	7	25	24
	Ciales	22,906	6,917	30.2	22,134	9.4	6,684	44	2	2	20	20
	Jayuya	14,589	4,728	32.4	15,838	32.6	5,133	34	5	6	12	11
	Lares	29,914	9,276	31.0	30,973	20.6	9,605	65	7	6	26	26
	Las Marias	9,626	2,947	30.6	10,544	19.8	3,229	22	2	2	9	9
	Maricao	7,724	2,537	32.8	8,141	18.1	2,674	18	2	1	7	8
	San Sebastian	30,266	9,622	31.7	36,197	14.1	11,507	77	6	5	33	33
	Utuado	42,531	13,514	31.7	40,968	5.4	13,016	88	2	3	42	41
								411	33	32	174	172
7	Aguas Buenas	14,671	4,470	30.4	14,817	14.2	4,514	30	2	2	13	13
	Aibonito	16,819	5,520	32.8	16,320	27.7	5,356	36	5	5	13	13
	Barranquitas	17,096	5,319	31.1	18,829	10.8	5,858	39	2	2	18	17
	Caguas	53,356	18,700	35.0	62,439	44.4	21,885	147	34	31	40	42
	Cayey	31,391	10,672	34.0	32,965	14.9	11,208	75	6	5	32	32
	Cidra	20,392	6,385	31.3	20,116	13.3	6,298	42	3	3	18	18
	Comerio	18,539	5,887	31.7	20,696	17.5	6,571	44	4	4	18	18
	Corozal	20,458	6,105	29.8	23,484	9.9	7,008	47	2	3	22	20
	Gurabo	15,870	4,964	31.2	16,352	25.6	5,115	34	5	4	12	13
	Juncos	19,464	6,692	34.3	19,503	20.0	6,705	45	4	5	19	17
	Las Piedras	15,389	4,761	30.9	16,076	13.0	4,974	33	2	2	15	14
	Morovis	19,167	5,870	30.6	18,367	13.2	5,626	38	2	3	17	16
	Naranjito	13,954	4,186	30.0	15,300	11.0	4,590	32	2	2	14	14
	Orocovis	19,770	6,040	30.5	22,226	8.0	6,790	46	2	2	21	21
	San Lorenzo	26,627	8,324	31.2	28,947	17.1	9,049	61	5	5	26	25
								749	80	78	298	293
	Totals											
1	Region	109,536	36,737	33.5	123,008	24.4	41,362	278	33	35	104	106
2	Region	565,597	204,755	36.2	709,379	58.2	259,165	1,740	502	512	360	366
3	Region	134,742	45,319	33.6	145,795	21.5	49,135	330	36	35	131	128
4	Region	356,065	127,236	34.8	404,028	41.3	144,551	970	203	198	287	282
5	Region	200,240	69,078	34.5	224,876	40.6	77,683	522	105	107	154	156
6	Region	180,112	57,020	31.6	193,149	15.8	61,250	411	33	32	174	172
7	Region	322,963	103,895	32.1	346,437	21.0	111,547	749	80	78	298	293
	Puerto Rico	1,869,255	644,040	34.4	2,146,672	39.7	744,693	5,000	992	997	1,508	1,503

shine is 2,847 in San Juan; thus there is a high level of solar ultra-violet radiation. The mean barometric pressure at San Juan is 29.90 inches, and the mean relative humidity is 78 per cent at 9 A.M., 76 per cent at 12 noon, and 80 per cent at 9 P.M. Therefore, one sees no sudden changes in temperature, a stable barometric pressure, and a fairly high humidity.

The original Indian population of Puerto Rico was rapidly subjugated by the Spanish and to all intents and purposes disappeared perhaps as early as 1544. In 1815 foreigners were invited to settle on the island, being offered free land and trade, citizenship, and permission to bring negro slaves, although the latter were first introduced in 1510. Immigrants came from the French and English Antilles, Haiti, Santo Domingo, and Venezuela. In 1873 the negro slaves were freed and in 1898 Puerto Rico became a United States possession.

As a result of its history the island population is a heterogeneous one varying from the Mediterranean Caucasoid to the West African Negro racial type, including no doubt, genotypically speaking, the American Indian. The bulk of the population shows various degrees of mixture. In 1940 the total population numbered 1,869,255 with a high density of 546 per square mile. The available 1950 Census figures show a total population of 2,210,703, with a density now of 645 per square mile.

Although full-fledged vitamin deficiency is not widespread in Puerto Rico, nevertheless studies of sprue, hookworm, ascaris, schistosoma, and of diets—the latter showing a grave scarcity of protein, calcium, vitamins A, C, and G—all indicate a population living near or on the borderline of nutritional insufficiency.[1]

[1] Blanco, Ana T., *Nutrition studies in Puerto Rico*, Rio Piedras, Puerto Rico, Social Science Research Center, University of Puerto Rico, 1946. Roberts, Lydia J., and Rosa L. Stefani, *Patterns of living in Puerto Rican families*, Rio Piedras, Puerto Rico, Dept. of Home Economics, University of Puerto Rico, 1949.

Sample Explanation

A. Census region, from 1940 Census, Puerto Rico, Bulletin No. 3.
B. Municipios in each census region.
C. Total population, by municipio, 1940 Census, Puerto Rico, Bulletin No. 2, Table 16.
D. Population ages 20–44, by municipio, 1940 Census, Puerto Rico, Bulletin No. 2, Table 18.
E. D divided by C, multiplied by 100, taken to one decimal place.
F. Estimate made by the Bureau of Registry and Vital Statistics of the Department of Health, Government of Puerto Rico for July 1, 1948, based on an arithmetic extrapolation from the census of December 1, 1935, and April 1, 1940.
G. Per cent urban, obtained from same source as F, taken to one decimal place.
H. Per cent from E applied to F. See F. P. Bartlett and B. Howell, Puerto Rico and its Population Problem, Government of Puerto Rico, 1946, Graph 16.
I. Sample total, 1948, ages 20–44, apportioned by municipio to give a total sample of 5,000. Obtained by dividing municipio figure, column H, by Puerto Rico total column H, and multiplying by 5,000.
J and K. Total of J and K equals per cent from G applied to I.
L and M. Total of L and M equals I minus total of J and K.

The male-female breakdown of each municipio sample is based on the 1940 sex ratio, ages 20–44, for each census region with a predetermined assumption that a total of 2,500 or 50 per cent of the total sample would be of each sex. The calculations are as follows.

Region	1940 20–44		1940 % of Total		1940 Ratio M/F (1)	1948 Region sample (2)	Excess (1) × (2)		1948 Sample	
	M	F	M	F			M	F	M	F
1	18,123	18,614	5.645	5.762	979.6	278	—	2.72	137	141
2	100,977	103,788	31.456	32.129	979.0	1,740	—	17.03	862	878
3	23,703	21,616	7.383	6.691	1,103.4	330	3.64	—	167	163
4	63,702	63,534	19.844	19.667	1,008.9	970	9.78	—	490	480
5	33,645	35,433	10.481	10.968	955.5	522	—	4.98	259	263
6	28,669	28,351	8.930	8.776	1,017.5	411	4.18	—	207	204
7	52,188	51,707	16.257	16.006	1,015.6	749	7.60	—	378	371
	321,007	323,033				5,000			2,500	2,500

M/F (1) is not a sex ratio but a factor from the 1940 census to be applied to the 1948 region sample to get the difference in number of each sex for the region. For example: Region 2 total sample equals 1,740. Excess females equal 17.03. Dividing 1,740 by 2 equals 870 (if males equaled females). Divide excess by 2 (17.03/2), which equals 8.5. Subtract 8.5 from 870, which equals 861.5. Also add 8.5 to 870, which equals 878.5. The figures used were 862 males and 878 females. The males and females must equal the region sample, i.e.: 1,740. Finally the municipio male-female sample, urban and rural, was adjusted so that the totals would match the regional figures previously determined.

SAMPLE STRUCTURE

It is probably not an exaggeration to say that almost all existing blood pressure studies suffer from two gross and fundamental errors. First, the samples used are by no means representative of the population in question, and secondly, unreliable standards derived from such samples are then applied to individuals. I had occasion to mention the first error a few years ago.[2]

Since the original Puerto Rico sample was carefully calculated and a modification of it is used in this study it will be described at some length.

The calculated sample structure is shown in table 1, and with the aid of the sample explanation that follows the table the latter should be self-explanatory. It will be noted that this sample was designed to give 2,500 males and 2,500 females or a total of 5,000 individuals. Table 1 does not indicate separately the negro breakdown since the Puerto Rican census data on race is not reliable.

After a few weeks of collecting this sample it became clear that in the time allotted for the research such a sample was too large. Accordingly a decision was made to obtain a sample two thirds as large as the original one, namely a total of 3,333 individuals. Table 2 indicates the new male and female calculated sample by region and municipio, the urban and rural figures being added together. Table 2 also shows the actual numbers obtained.

Table 3 is a percentage summary of table 2 by region. Region 2 in the male actual sample is overloaded. This is largely due to the fact that region 2 was the first region worked in when the originally calculated male sample was supposed to be 2,500. However San Juan in region 2 is the largest urban center and is a pool supplied from all the island regions, as is doubtless the area between Vega Alta and Carolina; hence any excess individuals obtained in this part of region 2 probably does not materially alter the representativeness of the total actual sample. The calculated and actual female samples by region are remarkably close. The total figure of 1,505 females in the actual sample is due to the elimination of females who were pregnant, or had no blood pressure recorded, or were 55 years of age and over.

Table 4 shows the age distribution of the actual sample compared to the 1940 census figures. The reason for the inclusion of individuals 17–19 and

[2] Murrill, R. I., A blood pressure study of the natives of Ponape Island, Eastern Carolines, *Human Biology* **21**: 47–59, 1949.

TABLE 2

CALCULATED COMPARED TO ACTUAL SAMPLE

Region	Municipio	Male		Female	
		Calculated	Actual	Calculated	Actual
1	Aguadilla	34	37	35	34
	Camuy	15	13	16	14
	Hatillo	15	6	15	7
	Isabela	18	11	19	10
	Quebradillas	9	18	9	16
		91	85	94	81
2	Arecibo	64	108	64	70
	Barceloneta	15	14	15	7
	Bayamon	35	54	35	17
	Carolina	21	103	21	70
	Catano	10	8	10	2
	Dorado	8	16	8	—
	Guaynabo	18	27	19	3
	Loiza	17	73	18	36
	Manati	23	38	24	21
	Rio Grande	12	21	12	9
	Rio Piedras	85	32	87	47
	San Juan	210	201	214	184
	Toa Alta	9	16	10	6
	Toa Baja	11	21	11	6
	Trujillo Alto	9	2	9	4
	Vega Alta	11	35	11	25
	Vega Baja	17	36	17	23
		575	805	585	530
3	Ceiba	4	6	4	2
	Culebra	—	2	—	1
	Fajardo	19	35	19	26
	Humacao	26	35	26	30
	Luquillo	7	2	7	4
	Maunabo	9	5	8	7
	Naguabo	13	15	13	6
	Vieques	8	4	8	1
	Yabucoa	25	16	24	8
		111	120	109	85
4	Arroyo	11	10	11	12
	Coamo	20	13	19	8
	Guanica	11	11	11	1
	Guayama	31	29	30	52
	Guayanilla	13	2	13	—
	Juana Diaz	24	18	23	23
	Lajas	13	13	12	5
	Patillas	15	15	15	26
	Penuelas	12	8	11	11
	Ponce	100	90	99	107
	Sabana Grande	13	14	13	4
	Salinas	18	13	18	9
	Santa Isabel	13	4	12	5
	Villalba	9	19	9	24
	Yauco	24	24	24	3
		327	283	320	290

TABLE 2—*Continued*

Region	Municipio	Male		Female	
		Calculated	Actual	Calculated	Actual
5	Aguada	15	17	15	18
	Anasco	12	19	12	9
	Cabo Rojo	23	29	24	14
	Hormigueros	5	5	5	6
	Mayaguez	74	99	74	100
	Moca	14	5	14	7
	Rincon	7	3	8	3
	San German	22	21	23	10
		172	198	175	167
6	Adjuntas	22	13	21	14
	Ciales	15	23	15	17
	Jayuya	11	6	11	7
	Lares	22	25	22	29
	Las Marias	7	11	7	12
	Maricao	6	9	6	3
	San Sebastian	26	26	25	27
	Utuado	29	30	29	35
		138	143	136	144
7	Aguas Buenas	10	12	10	7
	Aibonito	12	11	12	9
	Barranquitas	13	10	13	12
	Caguas	49	72	48	64
	Cayey	25	29	24	27
	Cidra	14	13	14	12
	Comerio	15	16	15	13
	Corozal	16	16	15	10
	Gurabo	11	4	11	3
	Juncos	15	5	15	3
	Las Piedras	11	9	11	2
	Morovis	13	19	13	12
	Naranjito	11	13	11	11
	Orocovis	16	15	16	8
	San Lorenzo	21	25	20	15
		252	269	248	208
	Totals	1,666	1,903	1,667	1,505

45–54 years of age is that we did not choose individuals primarily on the basis of age. Our first endeavor was to get municipio and region representation.

Table 5 indicates the calculated and actual sample urban and rural percentages. Again subjects were not chosen primarily for urban or rural residence. Especially in the smaller regions one can expect random variation to account for differences. Of greater importance is that the total urban-rural percentages are close. For the total actual sample the male plus female urban percentage is 39.4 and the rural 60.6. It is of some interest to observe that the obtainable 1950 Census figures show that the male plus female urban percentage for the whole of Puerto Rico is 40.5 and the rural is 59.5.

As a further piece of evidence and an important one concerning the actual sample, I can cite an interesting experiment conducted by Dr. Thieme, my colleague on this research project. In a study on Puerto Rican blood types where he calculated the ABO and Rh frequencies for those individuals typed in the actual sample, he states, "Because those not typed were not randomly spread through the sample, or not random by municipio, the blood type sample is not as accurately representative of the total population as the calculated sample. However, when the municipios are combined into regional districts, as has been done, no one section of the island is insufficiently represented in the final sample." [3] Despite the latter part of this statement, Thieme calculated the frequencies in a corrected sample designed to give the exact proportions of the calculated sample, and compared those frequencies with the actual ones. This comparison is shown in table 6. There are no significant differences.

It is not claimed that the actual sample used in this study, in regard to the categories mentioned, is absolutely representative of the total population. The only way to obtain a completely representative sample is to take the entire population, obviously an unfeasible task when the population is very large. What is claimed here is that an attempt was made to obtain as representative a

TABLE 3

REGION DISTRIBUTION OF SAMPLE

Region	Male				Female			
	Calculated		Actual		Calculated		Actual	
	No.	%	No.	%	No.	%	No.	%
1	91	5.5	85	4.5	94	5.6	81	5.4
2	575	34.5	805	42.3	585	35.1	530	35.2
3	111	6.7	120	6.3	109	6.5	85	5.6
4	327	19.6	283	14.9	320	19.2	290	19.3
5	172	10.3	198	10.4	175	10.5	167	11.1
6	138	8.3	143	7.5	136	8.2	144	9.6
7	252	15.1	269	14.1	248	14.9	208	13.8
Totals	1,666	100.0	1,903	100.0	1,667	100.0	1,505	100.0

[3] Thieme, F. P., The geographic and racial distribution of ABO and Rh Blood types and tasters of PTC in Puerto Rico, *Amer. Jour. Human Genet.* **4**: 94–112, 1952.

TABLE 4

AGE DISTRIBUTION OF SAMPLE

Ages	Male				Female			
	1940 Pop'n		1948 Sample		1940 Pop'n		1948 Sample	
	No.	%	No.	%	No.	%	No.	%
17–19	*61,483	13.7	92	4.8	*64,648	14.5	71	4.7
20–24	102,464	22.8	588	30.9	103,862	23.2	452	30.0
25–29	72,263	16.1	418	22.0	75,745	17.0	315	20.9
30–34	52,012	11.6	300	15.8	50,584	11.3	239	15.9
35–39	50,529	11.2	227	11.9	50,609	11.3	251	16.7
40–44	43,739	9.7	171	9.0	42,233	9.5	103	6.8
45–49	36,186	8.1	84	4.4	32,816	7.3	57	3.8
50–54	30,639	6.9	23	1.2	26,352	5.9	17	1.1
	449,315	100.0	1,903	100.0	446,849	100.0	1,505	99.9

* Approximate figure. Census data not available for this age group.

sample as possible of the male and female population of Puerto Rico, ages 20–44, and that no known bias favored any one segment of the population. Furthermore, the sample used here is immeasurably more representative of the Puerto Rican population than blood pressure samples, cited in the literature, are of other populations. One has only to examine the latter samples to observe the truth of this remark.

METHOD

1. *Questionnaire*

Each individual in the actual sample was first questioned regarding age, occupation, urban or rural residence, and duration in years of residence in the municipio. A series of special questions, based on Roberts' [4] pre-published data, was then asked in order to place the individual in one of the four main nutritional classes. The latter are described in some detail in Part I, under the heading "General Analysis of Puerto Rican Blood Pressures," Section F. The basic assumption made here is that since Puerto Rican food habit patterns are very strong, and assuming further that no marked increase of income had occurred, then the dietary pattern as stated by individuals at the time of questioning, or their present age, was the same as it had always been prior to the time of questioning.

TABLE 5

URBAN-RURAL DISTRIBUTION OF SAMPLE

Region	Male				Female			
	Calculated %		Actual %		Calculated %		Actual %	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
1	25.0	75.0	23.5	76.5	24.5	75.5	16.0	84.0
2	58.1	41.9	34.2	65.8	58.3	41.7	40.6	59.4
3	21.6	78.4	37.5	62.5	21.1	78.9	48.2	51.8
4	41.9	58.1	44.5	55.5	41.3	58.7	51.7	48.3
5	40.7	59.3	48.0	52.0	40.3	59.7	49.7	50.3
6	15.3	84.7	21.7	78.3	15.4	84.6	23.6	76.4
7	20.4	79.6	42.0	58.0	21.1	78.9	49.0	51.0
Total	39.7	60.3	37.0	63.0	39.8	60.2	42.4	57.6

2. *Blood Pressure Measuring Technique*

After the individual had been questioned, a series of anthropometric measurements were made. Next, the individual was seated and a dental examination was made and temperature taken. The blood pressure was then taken, some ten minutes after the individual had been seated. The individual's arm rested on a table at about heart level. One reading was taken by the auscultatory method, always on the right arm, using a Tycos aneroid sphygmomanometer with a 12 cm. arm band. The systolic reading was taken at the appearance of the first sound and the diastolic at the point at which sounds become dull and muffled.[5]

[4] Roberts, *op. cit.*

[5] Standard method for taking and recording blood pressure readings, *Jour. Amer. Med. Assn.* **113**: 294–297, 1939.

TABLE 6

COMPARISON OF TOTAL ACTUAL SAMPLE WITH TOTAL CALCULATED SAMPLE FOR FREQUENCIES OF ABO AND Rh TYPES

	No.	O	A_1	A_2	B	A_1B	A_2B
				ABO			
Calculated	3,333	53.88	24.88	9.70	9.49	1.01	1.04
Actual	3,245	53.99	24.84	9.61	9.52	.99	1.05
Difference*		+.11	−.04	−.09	+.03	−.02	+.01
				Rh			
	No.	rh	rh′	rh″	rh′ rh″	Rh_0	Rh_1	Rh_2	Rh_1 Rh_2
Calculated	3,333	8.53	1.16	0.46	0.11	12.82	48.75	15.46	12.71
Actual	2,528	8.78	1.23	0.47	0.12	13.21	48.89	14.79	12.50
Difference*		+.25	+.07	+.01	+.01	+.39	+.14	−.67	−.21

* None of the differences shown is significant.

3. *Ethnic Factor*

The Puerto Rican population being a heterogeneous one, an attempt was made to sort the population into phenotypically similar groups. An "ethnic factor" was devised using, in descending order of importance, the criteria of skin color, hair form, nose shape or width and lip thickness. The "ethnic factor" was calculated in the following manner: (1) Skin color was compared with the von Luschan skin color scale. Recorded values ranged from 7 to 32 with a mean value of 16 for the total sample. (2) Hair form was recorded on a 5-point scale using the values 0, 4, 6, 12 or 16—hair form thus contributing approximately one half of the value of skin color in the "ethnic factor" total. (3 and 4) Nose shape and lip thickness were recorded also on a 5-point scale, using the values 0, 2, 4, 6, or 8—thus these characteristics contributed approximately one half of the value of hair form.

By adding the values of the four phenotypic characteristics a total of 7–64 was possible, the low number presumably representing the extreme white phenotype and the high number the extreme negro phenotype. The range of possible values 7–64 was divided into 10 groups (0–9 inclusive), each individual being assigned to one group. As Thieme states,[6]

> Inasmuch as the characters used are those most variable in a Negro-White mixed population, they do indicate the general racial affinities of the groups. . . . it is assumed that within any one of these "ethnic groups" the genetic homogeneity is probably greater than in any combination of these groups, and certainly greater than in a combination of extreme groups.

[6] Thieme, *op. cit.*

4. *Statistics. Level of Confidence*

The tedious statistical calculations in this study were done and checked by the author mainly on IBM machines at the Watson Scientific Computing Laboratory of the International Business Machines Corporation. The standard error is used in preference to the probable error. In testing for significance of difference a t value of 2.58 or a significance at the 1 per cent level of confidence was originally decided upon for use throughout this study. The main reason for using such a rigorous test is that the methodological approach to *blood pressure* differences in this study is for the most part new. Furthermore it is the author's opinion that many blood pressure differences cited in the literature as significant are spurious precisely because of the lack of rigorousness of the statistical test.

5. *Blood Pressure Measurement. Personal Error*

At this point it must be mentioned that the blood pressure readings were taken by two of my colleagues, Dr. Fred Thieme and Miss Joanne Finkle. As this introduces the factor of personal error in measurement, sub-samples were devised

to test the significance of difference between the observers.

The technique used to obtain the personal error sub-sample was as follows. Those males whose blood pressure was measured by Finkle were first sorted out. These were shuffled and every fourth individual was selected to obtain a sample of 200. The variables considered to be important were age, region, nutritional class, and ethnic group. Each age group was then analyzed in regard to the different regions (1–7) and the latter in regard to the number of individuals who were of a particular nutritional class (1–4) who in turn were of a particular ethnic group (0–8, few individuals in the total sample fell into ethnic group 9). The males measured by Thieme were then shuffled and by random sorting were matched regarding the above variables, with Finkle's males. We may call this test sample A, male. Exactly the same procedure was used for the females, resulting in a second sample which we may call test sample B, female.

For testing the significance of difference in all *matched* samples in this study the formulae used for determining the significance of difference between matched samples are as follows: Let D_{sys} and D_{dias} represent the difference in the systolic and diastolic scores. Then $\Sigma D_{sys}/N$ and $\Sigma D_{dias}/N$ will equal the mean systolic and diastolic difference. Let the latter be represented by the symbols $M_{D\,sys}$ and $M_{D\,dias}$. Also let $\sigma_{D\,sys}$ represent the standard deviation of the systolic difference which equals $\sqrt{\Sigma(D_{sys}^2)/N - \Sigma(D_{sys})^2/N}$, and let $\sigma_{D\,dias}$ represent the diastolic difference standard deviation.

The standard error of the mean systolic and diastolic difference may be represented by $\sigma_{MD\,sys}$ and $\sigma_{MD\,dias}$, which equal $\sigma_{D\,sys}/\sqrt{N}$ and $\sigma_{D\,dias}/\sqrt{N}$. t_{sys} or t_{dias} is then found by $M_{D\,sys}/\sigma_{MD\,sys}$ or $M_{D\,dias}/\sigma_{MD\,dias}$.

Test sample A, male results were for systolic, $t = 1.819, P > .05$; for diastolic, $t = 1.247, P > .2$. Test sample B, female results were for systolic, $t = .180, P > .8$; for diastolic, $t = .717, P > .4$. These differences are not significant; hence for the remainder of this study the fact that Thieme or Finkle measured the individual's blood pressure will be disregarded.

6. *Obtaining Main Sample*

Individuals in the actual Puerto Rican sample were obtained in the following places, the numbers and percentages in parentheses being indicated. Males—Hospital Out-Patients 305 (16.0), Health Centers 895 (47.0), University of Puerto Rico Students 133 (7.0), Prisoners 394 (20.7), and Miscellaneous 176 (9.2). Females—Hospital Out-Patients 307 (20.4), Health Centers 1090 (72.4), and University of Puerto Rico Students 108 (7.1).

Owing to the low nutritional intake level in the general Puerto Rican population, Hospital Out-Patients, who were never from nutritional class 1, are probably no more "sick" than the average of the rest of the population which is not in nutritional class 1. A Health Center is where "healthy" individuals come for a brief examination to obtain a medical certificate for a labor permit. The largest part of the sample came from such centers. University of Puerto Rico students are on the average from the upper nutritional classes. Miscellaneous means individuals obtained from such places as the Borinquen air base or parents of school children summoned for examination. The prison system in Puerto Rico is not a harsh one; if anything food intake is more regular and perhaps slightly better than for non-prisoners. In short, a definite attempt was made to obtain as "healthy" individuals as possible.

7. *Non-prisoners versus Prisoners*

Owing to the fact that the male sample is composed of non-prisoners and prisoners, the blood pressure means of these two groups were compared. The results are as follows. For 1,509 non-prisoners the mean systolic pressure was $116.03 \pm .39$, the diastolic $71.19 \pm .29$. For 394 prisoners the mean systolic pressure was $117.04 \pm .74$, the diastolic $70.01 \pm .51$; t values are for systolic 1.21, and for diastolic 1.13, namely the differences are not significant. Therefore, in subsequent analysis of the male sample the latter will include both non-prisoners and prisoners.

8. *Ponderal and Body Build Indices*

In the blood pressure analysis of the male and female Puerto Rican sample use is made of a ponderal index to delineate weight groups, and a body build index to delineate body build types. Some explanation is necessary regarding these indices.

The ponderal index concept is taken from Robinson and Brucer who have used this index extensively in their blood pressure studies.[7] This index is obtained by dividing body weight by height.

[7] Robinson, S. C., M. Brucer, and J. Mass, Hypertension and obesity, *Jour. Lab. and Clin. Med.* **25**: 807–822, 1940.

In this study, body weight was measured in pounds and height in centimeters. Pearl in a devastating criticism of various body build indices in general use defends, however, the Wt/Ht index on the grounds that such an index is capable of straight forward physical interpretation and is easy to compute.[8] The author of the present study is well aware that weight is a *hybrid* dimension as Krogman has pointed out.[9] Nevertheless, even if one could analyze the effect of the various components of weight, such as skeleton, plasma, and total blood volume, extracellular fluid, etc., on blood pressure—obviously this would necessitate an extremely large sample not to mention laborious measuring techniques that cannot easily be carried out in the field.

Males were weighed dressed in a shirt and trousers, females in a dress, both sexes without shoes. Subsequently the ponderal index was calculated for every Puerto Rican male and female. The male mean ponderal index was 0.79 with a standard deviation of 0.10. The female mean ponderal index was 0.72 with a standard deviation of 0.13. For males the ponderal index standard range, or $\pm$ one standard deviation, is therefore 0.69–0.89, for females 0.59–0.85. The standard range was arbitrarily used to delineate those individuals who fell into a *medium-weight* category. Those individuals with a ponderal index below the standard range were assigned to a *light-weight* category, those above the standard range to a *heavy-weight* category. The distribution curve for the male ponderal index shows a positive skewness of 0.60, using the formula $3(\text{Mean} - \text{Median})/\sigma$, but there is no bi- or multimodality. The female distribution curve shows a positive skewness of 0.46, with no bi- or multimodality.

Robinson and Brucer have also pointed out that the ponderal index, which expresses body weight in relationship to height, should not be confused with a body build index which expresses robustness or the lack thereof, i.e., a person possessing an intermediate body build may be a light-weight or a heavy-weight. Robinson and Brucer favor the relationship Chest Circumference/Height to delineate body build types.[10] Pearl favors a habitus index obtained from the formula 100 × Chest Girth (at expiration) plus Abdominal Girth/Height.[11] Rees, on the basis of the factorial analysis of the intercorrelations of 20 measurements on a group of 200 soldiers, proposes a body build index obtained from the formula 100 × Height/(Transverse Chest Diameter × 6).[12] Unfortunately, chest circumference and diameter measurements were obtained only on the Puerto Rican males; hence the decision was made to use some other body build index, which could be calculated for both the Puerto Rican males and females.

The body build index selected was Height/$\sqrt[3]{\text{Weight}}$. Sheldon *et al.* have made use of this index in somatotyping.[13] The results obtained from using such an index should be interpreted with caution because the index suffers from the fallacy of trying to equate body weight and body volume, and Rees maintains that female body build cannot be measured by a simple ratio. With these reservations in mind the body build index calculations are as follows. The male mean body build index was 12.8, with a standard deviation of 0.4. The female mean body build index was 12.6, with a standard deviation of 0.7. For males the body build standard range is therefore 12.4–13.2, for females 11.9–13.3. Those individuals with a body build index below the standard range were assigned to a *linear* category, those within and above the standard range to an *intermediate* and *lateral* category. These terms are merely useful for the present study and should not be confused with the Sheldonian terms of ecto-, meso-, and endomorphy. The distribution curve for the male body build index shows a negative skewness of 0.75, with no bi- or multimodality. The female distribution curve shows a negative skewness of 0.42, with no bi- or multimodality.

GENERAL ANALYSIS OF PUERTO RICAN BLOOD PRESSURES

A. THE EFFECT OF AGE ON BLOOD PRESSURE

Table 7 shows the male and female mean systolic and diastolic pressures. At first sight it would be tempting to declare that the results indi-

[8] Pearl, R., An index of body build, *Amer. Jour. Phys. Anthropol.* **26**: 315–348, 1940.

[9] Krogman, W. M., Review of "The biology of human starvation," by Keys, A., *et al.*, *Amer. Jour. Phys. Anthropol.* **10**: 229–233, 1952.

[10] Robinson, S. C., and M. Brucer, Body build and hypertension, *Arch. Int. Med.* **66**: 393–417, 1940.

[11] Pearl, *op. cit.*

[12] Rees, L., The value of anthropometric indices in the assessment of body build, *Jour. Mental Sci.* **95**: 171–179, 1949.

[13] Sheldon, W. H., S. S. Stevens, and W. B. Tucker, *The varieties of human physique*, New York, Harper and Brothers, 1940.

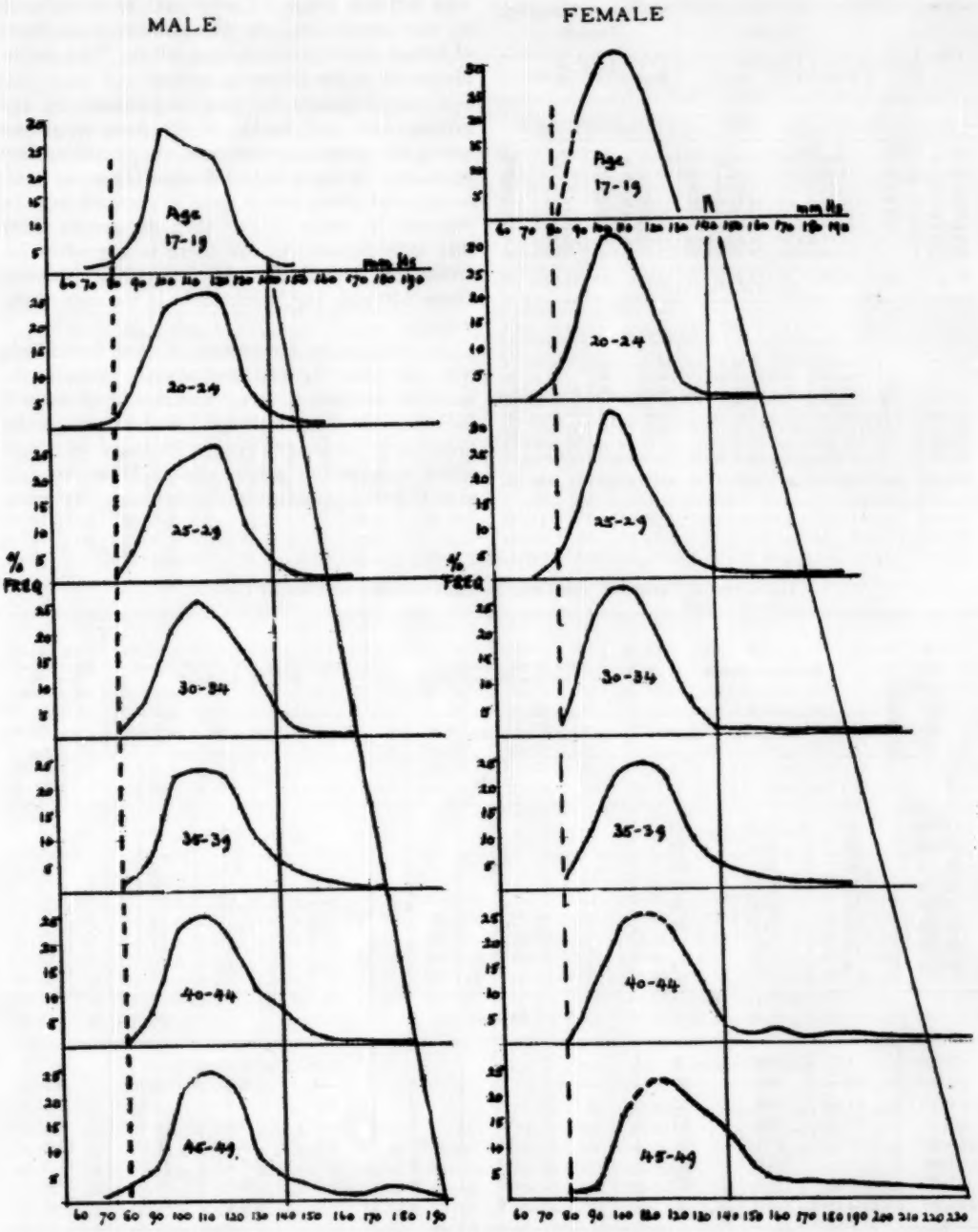

FIG. 2. Systolic pressure.

TABLE 7

THE EFFECT OF AGE ON BLOOD PRESSURE

Age	No.	Systolic		Diastolic	
		Mean ±S.E.	σ ±S.E.	Mean ±S.E.	σ ±S.E.
		Male			
17–19	92	113.04 ±1.38	13.24 ± .97	66.76 ± .95	9.20 ± .67
20–24	588	113.92 ± .56	13.60 ± .39	68.17 ± .43	10.64 ± .30
25–29	418	115.37 ± .65	13.48 ± .46	70.31 ± .53	10.88 ± .37
30–34	300	117.24 ± .83	14.41 ± .58	72.56 ± .56	9.83 ± .40
35–39	227	119.38 ±1.13	17.04 ± .79	74.61 ± .84	12.70 ± .59
40–44	171	118.69 ±1.26	16.53 ± .89	74.42 ± .85	11.23 ± .60
45–49	84	121.61 ±2.38	21.89 ±1.68	74.98 ±1.51	13.91 ±1.07
50–54	23	122.60 ±4.44	21.30 ±3.14	72.52 ±2.09	10.04 ±1.47
All ages	1,903	116.24 ± .34	15.20 ± .24	70.94 ± .25	11.35 ± .18
		Female			
17–19	71	109.61 ±1.18	9.98 ± .83	65.63 ±1.07	9.06 ± .76
20–24	452	108.14 ± .56	11.96 ± .39	64.78 ± .43	9.31 ± .30
25–29	315	109.18 ± .82	14.69 ± .58	66.44 ± .58	10.30 ± .41
30–34	239	112.61 ±1.16	18.04 ± .82	69.51 ± .77	11.97 ± .54
35–39	251	116.79 ±1.12	17.87 ± .79	71.61 ± .71	11.35 ± .50
40–44	103	122.80 ±2.83	28.79 ±2.00	73.82 ±1.30	13.26 ± .92
45–49	57	129.28 ±3.16	23.89 ±2.23	77.14 ±1.61	12.18 ±1.14
50–54	17	135.00 ±6.88	28.37 ±4.86	77.88 ±3.64	15.03 ±2.57
All ages	1,505	112.69 ± .46	17.88 ± .32	68.29 ± .29	11.39 ± .20

cate that, in the case of the males, and particularly in regard to the females, blood pressure increases with increase in age. One should beware of such an easy temptation, into which so many analyzers of human blood pressure have fallen. This can be illustrated in the following manner.

Figure 2 shows the systolic pressure, by age groups, male and female, in the form of graphs where the percentage frequency is plotted against pressure. If one selects 140 mm. Hg as an *arbitrary point* above which systolic pressure may be regarded as being "high," then the graphs show that with increase in age there is a gradual increase of individuals with a systolic pressure above 140 mm. Hg, particularly in the case of the females.

An analysis, by age groups, of those individuals with 140 mm. Hg and over systolic pressure reveals an interesting fact. Column D of table 8 indicates that the percentage 140 and over systolic pressure of *all* weight groups increases with age, which is what the graphs show. However, column C indicates quite clearly that with increasing

TABLE 8

140 SYSTOLIC PRESSURE AND OVER IN RELATIONSHIP TO WEIGHT GROUPS

	A No. in wt. groups			B No. in wt. groups with 140 systolic and over			C 140 systolic and over expressed as % of wt. groups			D % 140 systolic and over of wt. groups
	Lt.-Wt.	Med.-Wt.	Hy.-Wt.	Lt.-Wt.	Med.-Wt.	Hy.-Wt.	Lt.-Wt.	Med.-Wt.	Hy.-Wt.	All wts.
					Male					
17–19	13	72	7	—	2	1	—	2.8	14.3	3.3
20–24	87	449	52	—	16	4	—	3.6	7.7	3.4
25–29	50	307	61	—	15	5	—	4.9	8.2	4.8
30–34	31	218	51	2	14	5	6.5	6.4	9.8	7.0
35–39	26	165	36	2	23	4	7.7	13.9	11.1	12.8
40–44	20	118	33	1	13	6	5.0	11.0	18.2	11.7
45–49	16	56	12	2	6	5	12.5	10.7	41.7	15.7
50–54	4	16	3	1	4	—	25.0	25.0	—	21.7
					Female					
17–19	1	65	5	—	—	—	—	—	—	—
20–24	59	366	27	—	2	1	—	0.5	3.7	0.7
25–29	31	249	35	1	8	2	3.2	3.2	5.7	3.5
30–34	23	166	50	—	10	3	—	6.0	6.0	5.4
35–39	28	173	50	2	15	10	7.1	8.7	20.0	10.8
40–44	8	78	17	—	12	4	—	15.4	23.5	15.5
45–49	4	33	20	1	10	6	25.0	30.3	30.0	29.8
50–54	1	11	5	—	4	2	—	36.4	40.0	35.3

age the percentage particularly of *heavy-weights* with 140 and over systolic pressure increases, especially in the case of the females, and this fact clearly influences systolic pressure means.

Column C also seems to indicate that age may play some role in higher pressures in the light- and medium-weight groups, although it is perhaps most marked at the older ages.

It would appear then that the effect of age on blood pressure is not a simple one. In any event it would be wise, nay mandatory, to analyze the effect of weight groups on blood pressure in each age group.

B. THE EFFECT OF WEIGHT GROUPS ON BLOOD PRESSURE BY AGE

The Puerto Rican male and female samples were sorted into age groups and the latter into weight groups. The mean systolic and diastolic

TABLE 9

THE EFFECT OF WEIGHT GROUPS ON BLOOD PRESSURE BY AGE

LIGHT-WEIGHT						MEDIUM-WEIGHT					
Age	No.	Mean ± S.E.	σ ± S.E.	C.V.	Range	Age	No.	Mean ± S.E.	σ ± S.E.	C.V.	Range
Male Systolic						**Male Systolic**					
17–19	13	102.46 ± 2.31	8.36 ± 1.63	8.15	88–122	17–19	72	113.38 ± 1.48	12.64 ± 1.05	11.14	78–150
20–24	87	111.21 ± 1.37	12.86 ± .97	11.56	68–134	20–24	449	113.60 ± .64	13.64 ± .45	12.00	74–160
25–29	50	111.66 ± 1.59	11.27 ± 1.12	10.09	86–138	25–29	307	114.98 ± .78	13.79 ± .55	11.99	82–170
30–34	31	112.25 ± 2.83	15.77 ± 2.00	14.04	88–150	30–34	218	116.71 ± .93	13.86 ± .66	11.87	80–160
35–39	26	109.80 ± 2.74	13.98 ± 1.93	12.73	88–148	35–39	165	119.96 ± 1.33	17.21 ± .94	14.34	84–182
40–44	20	110.60 ± 3.61	16.16 ± 2.55	14.61	90–152	40–44	118	119.20 ± 1.56	17.00 ± 1.10	14.26	86–194
45–49	16	115.00 ± 5.52	22.11 ± 3.90	19.22	72–180	45–49	56	119.28 ± 2.31	17.33 ± 1.63	14.52	94–184
50–54	4	129.00 ± 12.25	24.51 ± 8.66	19.00	106–170	50–54	16	123.25 ± 5.36	21.46 ± 3.79	17.41	94–160
Male Diastolic						**Male Diastolic**					
17–19	13	60.76 ± 2.50	9.02 ± 1.76	14.84	46–74	17–19	72	67.27 ± 1.05	8.92 ± .74	13.25	46–86
20–24	87	68.03 ± 1.18	11.04 ± .83	16.22	38–98	20–24	449	67.69 ± .50	10.63 ± .35	15.70	40–102
25–29	50	66.72 ± 1.37	9.73 ± .97	14.58	50–96	25–29	307	69.75 ± .61	10.72 ± .43	15.36	44–102
30–34	31	67.51 ± 1.65	9.22 ± 1.17	13.65	52–90	30–34	218	72.32 ± .67	9.89 ± .47	13.67	42–102
35–39	26	67.23 ± 1.89	9.67 ± 1.34	14.38	44–92	35–39	165	74.84 ± 1.00	12.89 ± .70	17.22	48–122
40–44	20	70.00 ± 2.44	10.91 ± 1.72	15.58	56–98	40–44	118	73.61 ± 1.03	11.24 ± .73	15.26	48–112
45–49	16	68.25 ± 2.60	10.41 ± 1.84	15.25	40–88	45–49	56	73.58 ± 1.42	10.69 ± 1.00	14.52	50–112
50–54	4	72.00 ± 3.39	6.78 ± 2.39	9.41	68–82	50–54	16	72.75 ± 2.86	11.44 ± 2.02	15.72	58–92
Female Systolic						**Female Systolic**					
17–19	1	114.00	—	—	—	17–19	65	109.92 ± 1.26	10.16 ± .89	9.24	90–136
20–24	59	102.50 ± 1.32	10.21 ± .93	9.96	82–126	20–24	366	108.60 ± .60	11.60 ± .42	10.68	74–142
25–29	31	105.61 ± 2.85	15.88 ± 2.01	15.03	78–158	25–29	249	108.55 ± .90	14.35 ± .64	13.21	82–190
30–34	23	103.82 ± 1.89	9.10 ± 1.34	8.76	86–122	30–34	166	112.31 ± 1.42	18.35 ± 1.00	16.33	80–210
35–39	28	113.64 ± 2.63	13.93 ± 1.86	12.25	94–142	35–39	173	115.09 ± 1.24	16.35 ± .87	14.20	80–190
40–44	8	111.75 ± 6.20	17.56 ± 4.38	15.71	90–138	40–44	78	121.91 ± 3.38	29.92 ± 2.39	24.54	84–278
45–49	4	120.00 ± 11.02	22.04 ± 7.79	18.36	88–150	45–49	33	130.78 ± 4.41	25.34 ± 3.11	19.37	100–232
50–54	1	132.00	—	—	—	50–54	11	136.63 ± 10.16	33.70 ± 7.18	24.66	100–200
Female Diastolic						**Female Diastolic**					
17–19	1	58.00	—	—	—	17–19	65	66.06 ± 1.13	9.17 ± .80	13.88	44–88
20–24	59	61.37 ± .98	7.56 ± .69	12.31	42–78	20–24	366	65.04 ± .48	9.21 ± .34	14.16	40–98
25–29	31	63.80 ± 1.48	8.27 ± 1.05	12.96	48–82	25–29	249	66.06 ± .64	10.21 ± .45	15.45	42–112
30–34	23	62.86 ± 1.76	8.44 ± 1.24	13.42	48–80	30–34	166	69.40 ± .97	12.60 ± .69	18.15	40–120
35–39	28	70.35 ± 1.80	9.55 ± 1.27	13.57	50–88	35–39	173	70.54 ± .85	11.22 ± .60	15.90	44–108
40–44	8	68.75 ± 2.97	8.42 ± 2.10	12.24	58–82	40–44	78	72.75 ± 1.45	12.85 ± 1.02	17.66	50–120
45–49	4	68.00 ± 3.60	7.21 ± 2.54	10.60	58–78	45–49	33	77.63 ± 2.31	13.32 ± 1.63	17.15	58–128
50–54	1	74.00	—	—	—	50–54	11	80.90 ± 5.08	16.84 ± 3.59	20.81	64–114

TABLE 9—*Continued*

HEAVY-WEIGHT

Age	No.	Mean±S.E.	σ±S.E.	C.V.	Range
Male Systolic					
17–19	7	129.14±3.29	8.71±2.32	6.74	114–144
20–24	52	121.26±1.59	11.47±1.12	9.45	94–155
25–29	61	120.36±1.57	12.27±1.11	10.19	96–152
30–34	51	122.52±2.02	14.45±1.43	11.79	100–170
35–39	36	123.66±2.58	15.53±1.83	12.55	102–174
40–44	33	121.75±2.33	13.41±1.65	11.01	104–150
45–49	12	141.33±8.26	28.64±5.84	20.25	102–200
50–54	3	110.66±1.60	2.77±1.13	2.50	108–114
Male Diastolic					
17–19	7	72.57±2.70	7.16±1.91	9.86	60–82
20–24	52	72.53±1.26	9.10± .89	12.54	44–92
25–29	61	76.04±1.37	10.73± .97	14.11	50–112
30–34	51	76.62±1.18	8.45± .83	11.02	60–99
35–39	36	78.88±1.90	11.43±1.34	14.49	64–116
40–44	33	80.03±1.54	8.87±1.09	11.08	64–99
45–49	12	90.50±5.50	19.08±3.89	21.08	62–136
50–54	3	72.00±1.88	3.26±1.33	4.52	68–76
Female Systolic					
17–19	5	104.80±2.16	4.83±1.52	4.60	98–112
20–24	27	114.29±2.84	14.78±2.01	12.93	90–164
25–29	35	116.88±2.19	12.99±1.55	11.11	90–156
30–34	50	117.68±2.57	18.23±1.82	15.49	94–190
35–39	50	124.44±3.14	22.26±2.22	17.88	88–178
40–44	17	132.11±6.02	24.83±4.25	18.79	102–194
45–49	20	128.65±4.75	21.25±3.35	16.51	92–178
50–54	5	132.00±6.71	15.01±4.74	11.37	120–158
Female Diastolic					
17–19	5	61.60±2.73	6.11±1.93	9.91	54–72
20–24	27	68.74±2.19	11.41±1.55	16.59	44–94
25–29	35	71.48±1.85	10.96±1.30	15.33	50–99
30–34	50	72.94±1.36	9.63± .96	13.20	56–110
35–39	50	76.02±1.64	11.62±1.16	15.28	52–102
40–44	17	81.11±3.47	14.31±2.45	17.64	60–112
45–49	20	78.15±2.26	10.14±1.60	12.97	60–101
50–54	5	72.00±4.19	9.38±2.96	13.02	62–86

pressures of these were determined and are shown in table 9.

Upon examination table 9 indicates two salient points. First, in any age group, male or female, whether it be systolic or diastolic pressure, where sample numbers are adequate, the mean pressures are lowest in the light-weights, intermediate in the medium-weights, and highest in the heavy-weights. This should be sufficient evidence to show the fallacy of giving mean pressures by age group without regard for weight group. However, one must remember the importance of variation. For example, in the male or female 35–39 age group, if one considers the range of systolic or diastolic pressure, it is evident that some light-weights have fairly high pressures and conversely some heavy-weights have somewhat low pressures. Naturally this point is always obscured in studies which only show mean pressures without the range or standard deviation.

Second, table 9 gives one some clue to the effect of age on blood pressure in the weight group in question. In this case it would be best to confine oneself to the age groups 20–24 to 45–49, because of the sample numbers involved.

In regard to the *light-weight* group it is extremely interesting to note that for systolic or diastolic pressure, male or female, there is no significant difference in pressures between the age groups 20–24 and 45–49. Male t values are for systolic 0.66, for diastolic 0.07. Females t values are for systolic 1.57, for diastolic 1.77.

The *medium-weight* group presents a somewhat conflicting picture. Between the age groups 20–24 and 45–49 the male systolic pressure shows no significant difference, t value 2.37, but the male diastolic pressure shows a significant difference between the age groups 20–24 and 25–29, t value 2.64, and thereafter up to the age group 45–49. Between the age groups 20–24 and 30–34 the female systolic pressure shows no significant difference, t value 2.43, but after age 35 the difference is significant. The female diastolic pressure shows no significant difference between the age groups 20–24 and 25–29, t value 1.29, but after age 30 the difference is significant.

The *heavy-weight* group results are as follows. Between the age groups 20–24 and 45–49 the male systolic pressure shows no significant difference, t value 2.39. The male diastolic pressure shows no significant difference between the age groups 20–24 and 30–34, t value 2.37, but after age 35 the difference is significant. Between the age groups 20–24 and 35–39 the female systolic pressure shows no significant difference, t value 2.39, but after age 40 the difference is significant. The female diastolic pressure shows no significant difference between the age groups 20–24 and 30–34, t value 1.63, but after age 35 the difference is significant.

In the heavy-weight group, in later years, more individuals have higher systolic pressures, particularly females, as has been already seen in table 8,

indicating that *the duration of obesity is an important factor in the establishment of higher pressures.*

Calculation of the median systolic pressure gives the following results, with the mean values shown in parenthesis. Light-weight group, age 20–24, male 112.4 (111.2), female 102.3 (102.5); age 45–49, male 115.5 (115.0), female 114.5 (120.0). Medium-weight group, age 20–24, male 113.9 (113.6), female 109.3 (108.6); age 45–49, male 117.1 (119.2), female 130.2 (130.7). Heavy-weight group, age 20–24, male 121.8 (121.2), female 113.3 (114.2); age 45–49, male 134.5 (141.3), female 127.5 (128.6).

This comparison of the median and mean values indicates that the greater increase of the mean compared to the median, between the ages of 20 and 49, is due to the high readings of a comparatively small number of individuals and not to the general group of males or females. Therefore, in any weight group in this sample, ages 20–49, male or female, it is doubtful that one could make the unequivocal statement that blood pressure increases with age.

Various investigators of human blood pressure have suggested that the diastolic pressure measurement is a more accurate indicator of possible ill health, because they felt, doubtless basing their views on the standard deviation, that the systolic varied more than the diastolic pressure. Again table 9 indicates that in all weight groups the male or female systolic pressure, by age group, has a larger absolute variation (standard deviation) than the diastolic pressure. But if one considers the relative variation (coefficient of variation), then up to 45 years of age say, for male or female, the diastolic varies more than the systolic pressure, except that in the female heavy-weight group the relative variation of the diastolic is greater than that of the systolic pressure only up to age 30.

Is there an absolute and/or relative increase in the range of readings with age? Apparently this depends on whether you are considering systolic or diastolic pressure. In all weight groups the trend seems to be, for male or female, that there is both an absolute and relative increase in age for the systolic but not the diastolic pressure.

Is the range of systolic and diastolic pressure, both absolutely and relatively, greater for females or males at ages over 40? In the light-weight group it is in general greater for males. In the medium-weight group it is greater for females, and in the heavy-weight group greater for females except in the age group 45–49. These results should be interpreted cautiously because small numbers are involved in the age groups over 40.

As an indicator of ill health, therefore, from the *statistical* point of view, it is somewhat debatable as to which is the "best" blood pressure measurement to use—the systolic or diastolic.

It is not the purpose of this study to explain the etiology of obesity, but to point out its effect on blood pressure. It is interesting to note that the relationship between weight and blood pressure was noticed as long ago as 1922 by Symonds, using insurance company records for males.[14] Arranging his study by build groups on a weight per unit height basis, he observed an increase in pressure with an increase in relative obesity for all ages. Using a small sample of white male and female cardiacs, compared to non-cardiacs, Pearl and Ciocco,[15] and Ciocco [16] have shown that the cardiacs were characterized as a group by greater body weight. Schwartz with a private patient male and female sample,[17] and Robinson and Brucer with an insurance company sample of both sexes,[18] have proved that at any age group light-weights have lower pressures than heavy-weights.

Short and Johnson, using insurees of unspecified sex, have pointed out that with an increase in overweight there is a marked decrease in vital capacity; furthermore that when overweight persists long enough to produce postural changes the vital capacity remains impaired regardless of weight reduction.[19] Dublin and Marks, using insurance company data for females, have shown that the trend of mortality, over 30 years of age, is a progression from low mortality for underweights to high mortality among the obese.[20]

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[14] Symonds, B., Blood pressure of healthy men and women, *Jour. Amer. Med. Assn.* **80**: 232–236, 1922.

[15] Pearl, R., and A. Ciocco, Studies on constitution; II. Somatological differences associated with diseases of the heart in white males, *Human Biology* **6**: 650–713, 1934.

[16] Ciocco, A., Studies on constitution. II. Somatological differences associated with diseases of the heart in white females, *Human Biology* **8**: 38–91, 1936.

[17] Schwartz, J., Clinical study of blood pressure in relation to body weight, *Medical Record* **152**: 102, Aug. 7; 128, Aug. 21, 1940.

[18] Robinson, S. C., M. Brucer, and J. Mass, Hypertension and obesity, *Jour. Lab. and Clin. Med.* **25**: 807–822, 1940.

[19] Short, J. J., and H. J. Johnson, The effect of overweight on vital capacity, *Proc. Life Ext. Examiners* **1**: 36–41, 1939.

[20] Dublin, L. I., and H. H. Marks, The build of women and its relation to their mortality, *Proc. Amer. Life Insur. Med. Dir. America* **25**: 203–232, 1939.

Wilens using 1250 necropsies, male and female results mixed,[21] has indicated that within any decade, over 35 years of age, the incidence of severe atherosclerosis is from two to four times greater in the obese than in the "poorly nourished," the latter presumably being the non-obese or light-weights. Finally Hahn, using an English schoolboy sample, ages 11–15, points out that theoretically at any of these ages one would expect a lower pressure in light-weights and a higher pressure in heavy-weights.[22]

It is unnecessary to continue this recitation of evidence. Some authors still maintain that there is no relationship between weight or weight groups and blood pressure. It is no longer necessary to attempt to prove the relationship—it is already obvious, and the Puerto Rican sample, which is far more representative of the general population than any of the above samples, is an excellent added piece of evidence.

C. THE CONCEPT OF NORMAL BLOOD PRESSURE

There has been for many years some confusion in the medical literature regarding the difference between average and normal blood pressure. As Stanley and Alvarez stated in 1930, "It should be obvious that if one decides to accept for insurance only those persons whose blood pressures fall within the limits of, let us say, 100 to 140 mm. Hg, the average is bound to come out at about 120 mm." [23]

Since most blood pressure standards of normality in the U.S.A. have been based on insurance company samples, such standards are clearly suspect for they reflect biased averages. In addition, most of the earlier studies quoted averages without mentioning either the standard error or standard deviation of the mean. In other words, the fact that blood pressure varies like any other biological phenomenon was ignored. Many medical practitioners in their private practice frequently have patients with a blood pressure 25–50 mm. above the "average"; nevertheless, these patients continue to live a full life span. Therefore, as Bordley and Eichna have pointed out, ". . . the limits of normal blood pressure as applied to groups by insurance companies are far too narrow to be applied to individuals." [24]

The resounding fallacy that underlies the above confusion is that the sampling technique of almost every investigator, from the point of view of establishing blood pressure norms, has been incredibly bad. Indubitably, no blood pressure sample yet exists that *is* representative of the general population of the U.S.A., and one can hardly use the excuse that the available census material is inadequate. Insurance company samples represent a highly selected group of "accepted risks." Robinson and Brucer, after criticizing this very point, proceeded to attempt to establish the range of normal blood pressure by using an insurance company sample of individuals who lived in and around Chicago, were mostly urban, relatively sedentary, and earned $1000 or over per annum! [25] Some samples purporting to show the influence of age on blood pressure in the aged, such as Master *et al.*,[26] were obtained almost entirely in New York City or, such as Russek,[27] from the "Sailors Snug Harbor," presumably also in New York City.

A more recent and ambitious attempt to obtain a representative sample of the general population was done by Master *et al.*[28] Even here the sample is taken from only nine states and represents civilian workers in industrial plants and army airfields. These examples are typical of supposedly "representative" samples. I shall resist the temptation of continuing this dreary list.

On the other hand, if one does obtain a representative sample of a given population, then blood pressure means with their standard deviations at least give one a basis from which one can proceed to establish the range of normal blood pressure as it applies to the given population. However, since weight groups obviously affect blood pressure, within any age group, the range of normal blood pressure should be stated in terms of the weight groups, and not just by age groups in which the

[21] Wilens, L. L., Bearing of general nutritional state on atherosclerosis, *Arch. Int. Med.* **79**: 129–147, 1947.

[22] Hahn, L., The relation of blood pressure to weight, height and body surface area in schoolboys aged 11 to 15 years, *Arch. Dis. in Childhood* **27**: 43–53, 1952.

[23] Alvarez, W. C., and L. L. Stanley, Blood pressures in 6000 prisoners and 400 prison guards, *Arch. Int. Med.* **46**: 17–39, 1930.

[24] Bordley, J., and L. W. Eichna, Normal blood pressure, *Intern. Clin.* **1**: 175–194, 1938.

[25] Robinson, S. C., and M. Brucer, The range of normal blood pressure, *Arch. Int. Med.* **64**: 409–444, 1939.

[26] Master, A. M., H. H. Marks, and S. Dack, Hypertension in people over 40, *Jour. Amer. Med. Assn.* **121**: 1251–1256, 1943.

[27] Russek, H. I., Blood pressure in the aged. A study of 1000 elderly male subjects, *Amer. Heart Jour.* **26**: 11–19, 1943.

[28] Master, A. M., L. I. Dublin, and H. H. Marks, The normal blood pressure range and its clinical implications, *Jour. Amer. Med. Assn.* **143**: 1464–1470, 1950.

TABLE 10

THE RANGE OF NORMAL BLOOD PRESSURE BY AGE AND WEIGHT GROUPS

Age	Lt.-Wt.			Med.-Wt.			Hy.-Wt.		
	Lower	Normal	Upper	Lower	Normal	Upper	Lower	Normal	Upper
Male Systolic									
20–24	86	95–128	136	87	96–131	140	99	107–136	144
25–29	90	97–126	134	88	97–133	142	96	105–136	144
30–34	81	92–132	143	90	99–134	144	94	104–141	151
35–39	82	92–128	137	86	98–142	154	93	104–144	154
40–44	79	90–131	142	86	97–141	153	95	105–139	148
45–49	82*	87–143	148*	85	97–141	153	98*	105–178	184*
Male Diastolic									
20–24	46	54–82	90	47	54–81	89	55	61–84	90
25–29	48	54–79	86	49	56–83	91	55	62–90	97
30–34	49	56–79	86	53	60–85	92	60	66–87	93
35–39	48	55–80	86	50	58–91	100	56	64–94	101
40–44	49	56–84	91	52	59–88	96	63	69–91	97
45–49	48	55–82	89	53	60–87	95	64*	66–115	118*
Female Systolic									
20–24	82	89–116	123	86	94–123	131	85	95–133	143
25–29	74	85–126	137	80	90–127	137	91	100–134	142
30–34	86	92–115	122	76	89–136	148	82	94–141	153
35–39	86	96–131	141	83	94–136	147	81	96–153	168
40–44	77	89–134	146	80*	84–160	181	83	100–164	181
45–49	77	92–148	163	81	98–163	180	87	101–156	170
Female Diastolic									
20–24	47	52–71	76	47	53–77	83	46	54–83	91
25–29	48	53–74	80	46	53–79	86	50	57–86	93
30–34	46	52–74	79	45	53–86	94	54	61–85	92
35–39	52	58–83	89	49	56–85	93	53	61–91	99
40–44	52	58–80	85	48	56–89	98	53	63–99	109
45–49	54	59–77	82	52	61–95	104	58	65–91	98

* Estimated.

To find proper weight group, divide weight in pounds, by height in inches multiplied by 2.54 cms. Weight group ponderal index ranges are as follows: *Male.* Lt.-Wt. X–0.68. Med.-Wt. 0.69–0.89. Hy.-Wt. 0.90–X. *Female.* Lt.-Wt. X–0.58. Med.-Wt. 0.59–0.85. Hy.-Wt. 0.86–X.

weight groups are lumped together. This is another common error.

Treloar has stated that, "It is well recognised in biostatistics that any attempt to fix limits of normal variation in a physiologic function is extremely hazardous."[29] Nevertheless, some arbitrary limits of normal blood pressure are necessary if one is trying to define statistically the range of normal blood pressure and also for comparative purposes. The arbitrary limits should not produce a sharp dividing line between normal and abnormal pressures, for this situation does not exist in real life.

Regarding this matter Master *et al.* state that,

> Certainly we may assume that any reading within one standard deviation of the mean is probably within the normal range, and it is not unreasonable to extend this normal range to cover 80 per cent of the observations, that is, 40 per cent on either side of the mean. On the other hand, any blood pressure

[29] Treloar, A. E., Normal blood pressure, *Arch. Int. Med.* **66**: 848–850, 1940.

reading departing 2σ or more from the mean is probably abnormal.[30]

This approach does not ignore the fact that blood pressure varies and the arbitrary limits of normal and abnormal pressures are probably consistent with the average general practitioner's experience.

A similar approach to the range of normal blood pressure is followed in this study. This is illustrated in table 10, which should be of considerable use to the general practitioner in Puerto Rico. In this table, "normal" refers to pressures 1.28σ or 40 per cent on either side of the mean, "lower" and "upper" refer to a pressure 1.96σ on either side of the mean. In this Puerto Rican sample, then, according to weight and age group, those pressures below the lower limit and those above the upper limit are probably abnormal. The zones lower-normal and normal-upper represent possibly borderline hypo- and hypertensive cases.

Table 10 also indicates, especially in the light-weight group, that the lower limit of normal diastolic pressure in Puerto Rico is around 55 mm. Hg. This does not necessarily mean that the individual is suffering from fatigue or lessened vitality. Light-weights tend to have low blood pressures.

As Robinson has stated,

> . . . it is clear that low blood pressure does not cause fatigue or lessened vitality, any more than high blood pressure causes an increase in physical efficiency. The degree of health or mental and physical fitness is not an attribute of blood pressure levels; rather it depends upon cellular oxidation and biochemical changes and these, in turn, aside from hereditary differences, are to a great degree dependent upon the extent of daily work an individual performs.[31]

Perhaps it would be better to say that mental and physical fitness depends in general upon a satisfactory state of nutrition and that the latter determines to a large extent the work capabilities of an individual.

D. THE EFFECT OF BODY BUILD ON BLOOD PRESSURE

The Puerto Rican males and females were sorted into the three categories of linear, intermediate, and lateral body build. These, in turn, were sorted into light-, medium- and heavy-weight groups. This technique of course disregards age.

[30] Master *et al., op. cit.*

[31] Robinson, S. C., Hypotension: The ideal normal blood pressure, *New England Jour. Med.* **223**: 407–416, 1940.

TABLE 11

BODY BUILD AND WEIGHT GROUPS IN RELATION TO BLOOD PRESSURE

MALE

			Lt.-Wt.	Med.-Wt.	Hy.-Wt.
Linear	No.	(a)	163	226	—
		(b)	113	164	—
	Systolic Mean ±S.E.	(a)	111.04 ±1.04	116.88 ± .94	—
		(b)	111.31 ±1.37	115.59 ±1.16	—
	Diastolic Mean ±S.E.	(a)	67.72 ± .75	72.34 ± .77	—
		(b)	66.88 ± .97	70.96 ± .92	—
Intermediate	No.	(a)	84	1,058	53
		(b)	133	1,134	109
	Systolic Mean ±S.E.	(a)	111.83 ±1.81	115.37 ± .45	122.49 ±1.72
		(b)	112.69 ±1.33	116.33 ± .44	123.03 ±1.22
	Diastolic Mean ±S.E.	(a)	66.98 ±1.27	69.83 ± .33	74.01 ±1.30
		(b)	68.63 ± .94	70.74 ± .33	75.50 ± .84
Lateral	No.	(a)	—	117	202
		(b)	1	103	146
	Systolic Mean ±S.E.	(a)	—	119.18 ±1.46	122.80 ±1.09
		(b)	—	120.90 ±1.67	123.95 ±1.39
	Diastolic Mean ±S.E.	(a)	—	72.70 ± .97	77.65 ± .79
		(b)	—	74.30 ±1.01	79.15 ± .98

(a) Based on Body Build Formula Height/$\sqrt[3]{\text{Weight}}$.
(b) Based on Body Build Formula Chest Circumference/Height.

The reason for using the above technique is that Robinson has pointed out that weight should be separated from build in order to see the relative effect of each on blood pressure.[32] Using an insurance company male and female sample, Robinson claims that when the weight factor is held constant, no matter what the weight group, for both male and female mean systolic and diastolic pressures increase from the linear to lateral build type.

In table 11 the results marked *a* show that for Puerto Rican males, within any weight group, as one proceeds from linear to lateral build mean systolic and diastolic pressures increase somewhat. However, none of these differences is significant. If one compares the weight groups, within the same build groups, the differences between means are significant. For example, linear build—light- to medium-weight systolic t value is 4.17, diastolic 4.31. Intermediate build—light- to heavy-weight systolic t value is 4.28, diastolic 3.88. Lateral build—medium- to heavy-weight, systolic t value is not significant, but the diastolic t value is 3.99.

[32] Robinson, S. C., Hypertension, body build and obesity, *Amer. Jour. Med. Sci.* **199**: 819–829, 1940.

Now it must be remembered that in this study body build was obtained by using the formula Height/$\sqrt[3]{\text{Weight}}$. Robinson and Brucer have maintained that the formula Chest Circumference/Height is a better delineator of body build.[33] As has been mentioned before the chest circumference measurement was taken only on the Puerto Rican males. Accordingly the formula Chest Circumference/Height was used to delineate body build for the Puerto Rican males. The mean of the latter formula was 0.52 with a standard deviation of 0.03, giving a standard range of 0.49 to 0.55, to which the intermediate build corresponds. Below 0.49 are linears and above 0.55 laterals. The mean systolic and diastolic pressures based on the formula Chest Circumference/Height are marked *b* in table 11.

The latter results show a trend very similar to the results obtained by using the formula Height/$\sqrt[3]{\text{Weight}}$. Holding body weight constant, only the heavy-weight—intermediate to lateral build—diastolic pressure difference is definitely significant, with a *t* value of 2.85. On the other hand, holding build constant, in each weight group from lighter to heavier weight, either the systolic or diastolic pressure differences are significant.

The female results are shown in table 12. Within any weight group as one proceeds from linear to lateral build the mean systolic and diastolic pressures increase, but with the exception of light-weight—linear to intermediate build mean diastolic pressure difference, *t* value 2.63—none of the differences is significant. In the linear build—light- to medium-weight—the mean systolic difference is not significant, but the diastolic is significant, *t* value 3.47. In the intermediate build—light- to heavy-weight—neither the mean systolic nor diastolic difference is significant. In the lateral build—medium- to heavy-weight—the mean systolic difference is significant, *t* value 2.97, also the diastolic, *t* value 2.83.

As far as the females are concerned a trend similar to the males is observable although not so clear cut. This is probably due to the fact that the correlation between body build and ponderal indices is greater in the males, i.e., male $r = -.917$, female $r = -.730$. It is possible that the formula Chest Circumference/Height, if it be the correct formula to use on females, might give results more in favor of body build than body weight.

The Puerto Rican sample, therefore, indicates that weight groups in males definitely, and in females probably, exert a greater effect on blood pressure than build groups.

TABLE 12

BODY BUILD AND WEIGHT GROUPS IN RELATION TO BLOOD PRESSURE

FEMALE

		Lt.-Wt.	Med.-Wt.	Hy.-Wt.
Linear	No.	99	64	—
	Systolic Mean ±S.E.	104.44 ±1.30	109.60 ±1.72	—
	Diastolic Mean ±S.E.	62.88 ± .84	67.89 ±1.18	—
Intermediate	No.	56	1,042	48
	Systolic Mean ±S.E.	110.21 ±1.94	112.13 ± .54	115.72 ±2.71
	Diastolic Mean ±S.E.	66.83 ±1.26	67.81 ± .35	70.08 ±1.81
Lateral	No.	—	35	161
	Systolic Mean ±S.E.	—	112.77 ±2.90	122.55 ±1.56
	Diastolic Mean ±S.E.	—	68.34 ±2.13	74.85 ± .88

[33] Robinson, S. C., and M. Brucer, Body build and hypertension, *Arch. Int. Med.* **66**: 393–417, 1940.

E. THE EFFECT OF URBAN OR RURAL LIFE ON BLOOD PRESSURE

There is a rather widespread idea that hypertension and urbanization are correlated. For example, Donnison states, "The literary evidence available affords quite an adequate amount of information regarding the incidence of hyperpiesis, . . . its incidence increases with development of towns and with education . . . ." [34] He gives no actual methodological proof for this statement.

Hashimoto *et al.*, using a sample of 3,530 males and 6,528 females, both sexes being poor outpatients who attended St. Luke's International Hospital in Tokyo, claimed a percentage of hypertension slightly over 9.0, hypertension being defined as a persistent systolic pressure of over 160 and diastolic over 100 mm. Hg.[35] As the authors point out the high incidence of hypertension in a hospital sample may be due to the hospital having a well-known cardiovascular clinic. In addition the authors state that the incidence of hypertension is higher among Japanese than Chinese. They evidently compared their sample with a sample of Chinese from the Hunan-Yale Hospital

[34] Donnison, C. P., *Civilization and disease*, Baltimore, W. Wood & Co., 1938.

[35] Hashimoto, H., K. Akatsuka, I. Tsujii, and H. Shiraishi, The incidence of hypertension among urban Japanese, *Ann. Int. Med.* **7**: 615–624, 1933–1934.

in South China. The Chinese were presumably rural, and, since both Japanese and Chinese are mongoloid, then the difference in the incidence of hypertension must be due not to race but to urbanization. An ingenious explanation based on no methodological proof whatsoever.

On the other hand, Gover, using a low-income farm (rural) sample of 2,749 males and 2,582 females drawn from only seventeen states in the U.S.A., came to the conclusion that the mean systolic pressure of specific age groups was *higher* than that of industrial urban workers, the mean diastolic pressure being about the same.[36] This author's urban workers are mainly drawn from Insurance Company samples, whose representativeness of urban workers throughout the U.S.A. is to be seriously questioned. Furthermore, weight groups in the rural and urban samples were not equated. Again the methodological approach is valueless.

Using the Puerto Rican sample the following methodology was used to test the possible difference between urban and rural life on blood pressure.

Obviously the first desideratum is that the individual should have lived all his or her life in an urban or rural area. Incidentally this important point is by no means clear in those blood pressure studies which have endeavored to test the effect of urban or rural life. Therefore, all those "all life" urban or rural *non-prison* males and urban or rural females were first sorted out in the Puerto Rican sample.

Random samples of 180 urban non-prison males and 200 urban females were then obtained and analyzed in regard to the following variables: age groups 20–44, weight group, nutritional class, and ethnic group. For example, age group 20–24 and subsequent age groups were divided into light-, medium- and heavy-weight groups, and each weight group analyzed regarding the number in each ethnic group who fell into nutritional classes 1–4. By random sorting rural non-prison male and rural female samples were obtained equal in number to the urban sample, each individual in the rural sample being matched with a similar individual in the urban sample. Finally both urban and rural samples were compared to the Puerto Rican calculated sample concerning the region distribution, prior to the actual test for significance of difference of blood pressures.

TABLE 13

THE EFFECT OF URBAN OR RURAL LIFE ON BLOOD PRESSURE

	Male				Female			
	Urban		Rural		Urban		Rural	
No.	180		180		200		200	
Av. Age	27.6		27.6		27.2		27.3	
% Lt.-Wt.	14.4		14.4		12.0		12.0	
% Med.-Wt.	73.9		73.9		78.5		78.5	
% Hy.-Wt.	11.7		11.7		9.5		9.5	
Av. Ht./$\sqrt[3]{\text{Wt.}}$	12.84±.04		12.87±.04		12.72±.04		12.68±.04	
Region	A %	B %	C %	D %	A %	B %	C %	D %
1	5.0	3.3	8.9	6.9	3.5	3.5	9.0	7.1
2	25.6	50.6	48.9	23.9	24.5	51.4	30.0	24.4
3	2.2	3.6	3.9	8.7	5.5	3.5	7.0	8.5
4	22.2	20.5	11.1	19.0	28.0	19.9	15.5	18.8
5	13.3	10.6	10.0	10.2	14.0	10.7	8.5	10.4
6	6.1	3.3	6.7	11.5	8.5	3.2	14.0	11.4
7	25.6	8.1	10.6	19.8	16.0	7.8	16.0	19.5
Systolic Mean±S.E.	116.75±1.01		115.92±1.17		111.50±1.05		112.07±1.05	
Diastolic Mean±S.E.	71.20± .79		71.31± .87		66.75± .71		67.90± .66	
Systolic Range	88–174		74–194		84–196		86–220	
Diastolic Range	44–116		44–118		42–116		44–108	

A and C. Actual Urban and Rural.
B and D. Calculated Urban and Rural.

The results are shown in table 13 and are self-explanatory with the exception of the region distribution and the mean systolic and diastolic pressures. The percentage region distribution figure is the per cent of the total regions, urban or rural. The main discrepancy is in region 2, but this is merely a reflection of the region urban-rural distribution of the actual Puerto Rican sample to be seen in table 5. The mean systolic and diastolic pressures with their accompanying standard errors are indicated purely as a matter of interest in this and subsequent tables dealing with matched samples. The test for significance of difference is *not* conducted using these standard errors, because we are dealing here again with matched samples or samples whose means are correlated.

Applying then the correct test for significance of difference between matched samples, as was done in the Thieme-Finkle test samples, the results are as follows: Male urban-rural systolic pressure, $t = .564, P > .5$, diastolic $t = .108, P > .9$. Female urban-rural systolic pressure, $t = .795, P > .4$, diastolic $t = 1.526, P > .1$. None of these differences is significant.

[36] Gover, M., Physical impairments of members of low-income farm families. VII. Variation of blood pressure and heart disease with age; and the correlation of blood pressure with height and weight, *Pub. Health Report* **63**: 1083–1101, 1948.

Hence it would appear that Puerto Ricans living in urban areas do not have higher blood pressures than those in rural areas, or the reverse.

F. THE EFFECT OF NUTRITIONAL CLASS ON BLOOD PRESSURE

Information regarding the nutritional aspect of Puerto Ricans was obtained mainly from the study of the main aspects of family living in Puerto Rican families of all socio-economic levels carried out by Lydia Roberts, Rosa Stefani and their co-workers.[37] This study used a representative sample of 1,044 families and was done in 1946. The validity of this sample—determined by checking against the 1940 U.S. Census, concerning such variables as urban-rural distribution, age distribution, size of family, sex distribution, and home ownership—is of noteworthy soundness.

Unfortunately all results concerning the adequacy of Puerto Rican diets in this study are given in percentages. The standards used for comparison were the recommended dietary allowances of the Food and Nutrition Board, National Research Council, Washington, D. C. Any dietary standard possesses the properties of a mean and the latter should be accompanied by its standard error and standard deviation for comparative purposes, as has been pointed out by Dann and Darby.[38] In any nutritional survey of a population the dietary intake results should be expressed in a similar fashion, as was done for example in a Tennessee rural population nutritional survey by Youmans *et al.*[39]

Nevertheless, Roberts and Stefani's Puerto Rican dietary study is the best we have so far. The authors have pointed out that Puerto Rican diets may be classed roughly into four main types.

In type I, comprising 12.8 per cent of all families, the day's diet, at its poorest, is made up almost entirely of *viandas* (starchy vegetables or fruits), rice, or *some other starchy food.* This diet is very low in all dietary factors, with the possible exception of calories. The intake of protein is only 50 per cent of the recommended daily allowance. Calcium and all the B vitamins meet only one fourth of the allowances, and vitamins A and C even less. This diet, at its best, with some codfish and a little milk, is markedly deficient in good protein, calcium and vitamin A.

In type II, comprising 33.6 per cent of all families, the day's diet is made up mostly of *rice and beans.* A diet of this type, at its poorest, fails to meet even 75 per cent of the daily allowances in everything but calories, protein and iron. Such a diet is extremely low in vitamins A and C, and at its best it is around 75 per cent of the allowances or less in all dietary factors, in fact below 25 per cent in calcium and vitamin A. Types I and II are typical of families with incomes less than $500 per year.

In type III, comprising 47.1 per cent of all families, the day's diet is made up mostly of *rice, beans, and viandas.* This diet is better than the preceding ones especially in thiamine and iron. At its poorest, the diet is very low in calcium, vitamins A and C, and riboflavin. At its best, with some codfish or other protein and milk it is still low in the above dietary factors. Type III is typical of families with incomes of $500 to $1,999 per year. The general inadequacy of type I–III diets is well-nigh incredible.

In type IV, comprising 6.5 per cent of all families, diets are *in general adequate* and are typical of families with an income of $2,000 and over per year. In this category diets contain meat or other protein food at two meals, soup once or twice, and one pint of milk or more per person daily. They also contain a good share of lard and sugar but the amounts of vegetables and fruits vary considerably. Interestingly enough upper income families also like to eat a portion of rice and beans. In fact, during my sojourn in Puerto Rico, my landlord—an upper income family man—informed me that, when he was visiting New York City, what he missed most in American restaurants was his "rice and beans." Type IV diets are adequate in all dietary factors with the possible exception of vitamins A and C, depending upon the intake of vegetables and fruits.

For the purposes of the present study types IV, III, II, and I were called nutritional classes 1, 2, 3, and 4. Since the above diets differ, especially nutritional class 1, any possible effect of this diet difference on blood pressure ought to be exam-

[37] Roberts, L. J., and R. L. Stefani, *Patterns of living in Puerto Rican families,* Rio Piedras, Puerto Rico, Dept. of Home Economics, University of Puerto Rico, 1949.

[38] Dann, W. J., and W. J. Darby, The appraisal of nutritional status (nutriture) in humans. With especial reference to vitamin deficiency diseases, *Physiol. Rev.* **25**: 326–346, 1945.

[39] Youmans, J. B., E. W. Patton, and R. Kern, Surveys of the nutrition of populations. Description of the population, general methods and procedures, and the findings in respect to the energy principle (calories) in a rural population in Middle Tennessee. Part 2, *Amer. Jour. Pub. Health* **33**: 58–72, 1943.

TABLE 14

THE EFFECT OF NUTRITIONAL CLASS ON BLOOD PRESSURE

	Male			Female		
	N. C. 1	N. C. 2	N. C. 3	N. C. 1	N. C. 2	N. C. 3
No.	85	85	85	95	95	95
Av. Age	27.9	26.6	27.2	28.0	28.3	27.9
% Lt.-Wt.	3.5	3.5	3.5	4.2	4.2	4.2
% Med.-Wt.	67.1	67.1	67.1	67.4	67.4	67.4
% Hy.-Wt.	29.4	29.4	29.4	28.4	28.4	28.4
Av. Ht./$\sqrt[3]{\text{Wt.}}$	12.69±.06	12.70±.06	12.58±.06	12.41±.07	12.48±.07	12.42±.07
Systolic Mean±S.E.	116.41±1.32	116.23±1.69	114.73±1.86	110.00±1.48	110.38±2.03	111.74±1.63
Diastolic Mean±S.E.	71.88± .97	68.95±1.28	69.91±1.32	66.65± .90	67.08±1.20	67.84±1.16
Systolic Range	92–158	82–162	76–164	80–178	80–190	82–172
Diastolic Range	56–102	42–118	42–102	48–95	44–104	46–102
	Lt.-Wt. %	Med.-Wt. %	Hy.-Wt. %	Lt.-Wt. %	Med.-Wt. %	Hy.-Wt. %
N. C. 1	3.0	57.0	40.0	3.9	62.7	33.3
N. C. 2	12.3	75.2	12.5	10.2	76.7	13.2
N. C. 3	16.9	72.5	10.6	12.4	77.1	10.5
N. C. 4	29.7	67.6	2.7	17.1	77.1	5.7

ined. Of course in the present case it is only possible to test the effect on blood pressure of one *type* of diet versus another. One is not testing here *one* dietary factor, the others being held constant. The latter kind of study on a representative sample of a given population, to my knowledge, has yet to be done.

It is worth mentioning at this point regarding the relationship of diet and hypertension that Chapman and Gibbons, in an excellent and exhaustive criticism, citing 226 references, of past and present experiments performed almost entirely on hospital patients, have concluded that none of the following has a definitely provable therapeutic value in hypertension: low intake of the sodium or chloride ion, including the so-called famous Kempner rice diet, which limits the intake of protein, salt, fluids and possibly calories; low intake of fat and cholesterol; excess or lack of protein, caffeine, alcohol, guanidine base compounds, watermelon seed or garlic(!).[40] In fact the only positive conclusion the authors arrive at concerns caloric intake, i.e., obesity is associated with an increased incidence of hypertension and weight loss in obese hypertensive patients often results in a decline in the blood pressure levels.

In spite of Chapman and Gibbons' conclusions the possible effect of the different nutritional classes in Puerto Rico on blood pressure was tested using the following methodology, omitting nutritional class 4 since unfortunately too few males and females belonging to this class existed in the actual Puerto Rican sample.

Since there may be a dietary difference between prisoners and non-prisoners in Puerto Rico only non-prison males were used. Since only 100 males and 102 females belonging to nutritional class 1 existed in the actual Puerto Rican sample the resultant samples for the test were not large. Random samples of 85 urban or rural non-prison males and 95 urban or rural females belonging to nutritional class 1 were obtained and analyzed in regard to the following variables: age groups 17–49, weight group, region and ethnic group. For example, age group 17–19 and subsequent age groups were divided into light-, medium- and heavy-weight groups, and each weight group analyzed regarding the number in each region who fell into ethnic groups 0–8. By random sorting male and female nutritional class 2 and 3 samples were obtained equal in number to the nutritional class 1 sample, each individual in the nutritional class 2 and 3 samples being matched with a similar individual in the nutritional class 1 sample.

The results are shown in table 14. Applying the correct test for significance of difference between matched samples the results are as follows: Male—nutritional class 1 and 2 systolic pres-

[40] Chapman, C. B., and T. B. Gibbons, The diet and hypertension, *Medicine* **29**: 29–69, 1950.

sure, $t = .092, P > .9$, diastolic $t = 1.831, P > .05$. Nutritional class 1 and 3 systolic pressure, $t = 1.175, P > .2$, diastolic $t = 1.814, P > .05$. Nutritional class 2 and 3 systolic pressure, $t = .889, P > .3$, diastolic $t = .110, P > .9$. Female—nutritional class 1 and 2 systolic pressure, $t = .157, P > .8$, diastolic $t = .330, P > .7$. Nutritional class 1 and 3 systolic pressure, $t = .806, P > .4$, diastolic $t = .922, P > .3$. Nutritional class 2 and 3 systolic pressure, $t = .666, P > .5$, diastolic $t = .571, P > .5$. None of these differences is significant.

Therefore, as far as nutritional classes 1–3 in Puerto Rico are concerned nutritional class *per se* does not appear to exert an influence on blood pressure.

However, attention is drawn to the bottom of table 14 where each nutritional class is analyzed concerning the percentage proportion of the weight groups. This shows quite clearly that the quantity and quality of the diet affect the proportion of weight groups, i.e., nutritional class 1, male or female, has a much larger proportion of heavy-weights than light-weights. Nutritional class 1 is also made up of families in the upper income bracket. In other words in Puerto Rico, the higher the income the better the quantity and quality of the diet and hence the more chance of putting on weight, especially since individuals belonging to this nutritional class occupationally probably are mostly sedentary workers. And yet as we have already seen the greater the amount of obesity the greater is the tendency for higher blood pressure levels.

If, as was done, the nutritional classes are *equated* in regard to the afore-mentioned variables, particularly weight groups, no significant difference is observable regarding the effect of the different nutritional classes on blood pressures. This suggests that the type of diet is not directly related to blood pressure levels but only indirectly in so far as nutritional class 1 has the greatest proportion of heavy-weights.

G. THE EFFECT OF CLIMATIC ENVIRONMENT ON BLOOD PRESSURE

Most of the existing studies on the relationship between climate and blood pressure have dealt with the effect of a temperate or tropical climate. The consensus of opinion is that "hypotension" exists in the tropics. The word "hypotension" is ill-chosen because it almost always has the connotation of a blood pressure that is below "normal" and hence "abnormal." By this criterion all light-weights in Puerto Rico have "abnormal" blood pressures, which is absurd.

Various reasons have been advanced in order to explain this so-called "hypotension," such as: a lowered peripheral resistance associated with increased secretory activity of the sweat glands; dilation of peripheral blood vessels, as well as increased elasticity of the vessel wall; the comparatively slower and calmer life in the tropics; a decreased capacity for muscular effort with a resulting decrease in muscular tone; diet; and on the rare occasion that a smaller stature and lighter weight might be important factors. All of these suggestions, however, are based on results exhibiting extremely poor methodology, and as long as the latter continues they will be entirely speculative.

Examples of the poor methodology used are: Scott *et al.*,[41] who subjected individuals to warm or cool rooms and observed the results on blood pressure, or Miller and Moor,[42] who put 113 syphilitic(!) patients in a fever cabinet—neither of these experiments represent acclimatization; or Roddis and Cooper,[43] Radsma *et al.*,[44] or MacPherson,[45] who used one group of individuals in a temperate and another in a tropical climate, ignoring such important variables as age, weight groups, or diet.

Exactly the same criticism can be leveled at those studies concerning the relationship between altitude and blood pressure, i.e., Smith,[46] Latham,[47] or Allegretti.[48] Incidentally aviation altitude is not acclimatization either.

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[41] Scott, J. C., H. C. Bazett, and G. C. Mackie, Climatic effects on cardiac output and the circulation in man, *Amer. Jour. Physiol.* **129**: 102–122, 1940.

[42] Miller, V. J., and F. B. Moor, Acute effects of hot saturated atmosphere upon the human temperature, heart rate, and blood pressure, as influenced by age, *Brit. Jour. Physical Med.* **10**: 167–171, 1947.

[43] Roddis, L. H., and G. W. Cooper, The effect of climate on blood pressure, *Jour. Amer. Med. Assn.* **87**: 2053–2055, 1926.

[44] Radsma, W., J. T. Meijman, and G. G. A. Mastenbroek, Measurements of pressure and pulse frequency of white men in the tropics and colder climates, *Nederl. Tydschr. Geneesk.* **82**: 4679–4691, 1938.

[45] MacPherson, R. K., The effect of exposure to humid tropical climates on the resting pulse rate and arterial blood pressures, *Fatigue Lab. Nat. Health and Med. Res. Counc., Australia,* Open Report, No. 7: 1–4, 1946.

[46] Smith, F. C., The effect of altitude on blood pressure, *Jour. Amer. Med. Assn.* **64**: 1812–1814, 1915.

[47] Latham, D. V., The white man in East Africa, *East African Med. Jour.* **9**: 276–282, 1932–1933.

[48] Allegretti, A. J., Blood pressure as affected by altitude, *Med. Bull. Vet. Admin.* **19**: 290–291, 1943.

As far as Puerto Rico is concerned the possible effect of climate on blood pressure is of course not one of a temperate versus a tropical climate. Nor does Puerto Rico have any area of great altitude. However, it does possess two regions, namely, 6 and 7, both of which are mountainous and at the same time humid, and a southern lowland region, namely, 4, which is also arid. It is of some interest to test the possible difference of these climatological regions on blood pressure.

The two climatological regions then to be tested are regions 6 and 7 taken together, omitting Caguas from the latter, which is a valley, and region 4. In a test involving the effect of climate it must be obvious that the individual should have lived all his or her life in the same region, in fact in the same municipio. Naturally this reduces the *number* of individuals or *regions* available for a test sample. Accordingly, such individuals were first sorted out. For males this meant using only non-prison males. For the purposes of the test the following methodology was used.

Random samples of 73 "all life" non-prison urban or rural males and 100 "all life" urban or rural females belonging to region 4 were obtained and analyzed in regard to the following variables: age groups 20–49, weight group, nutritional class, and ethnic group. For example, age group 20–24 and subsequent age groups were divided into light-, medium-, and heavy-weight groups, and each weight group analyzed regarding the number in each nutritional class that fell into ethnic groups 0–8. By random sorting male and female region 6 plus 7 samples were obtained equal in number to the region 4 samples, each individual in the former samples being matched with a similar individual in the latter samples.

TABLE 15

THE EFFECT OF CLIMATIC ENVIRONMENT ON BLOOD PRESSURE

	Male		Female	
	Region 4 (Arid)	Region 6+7 (Humid)	Region 4 (Arid)	Region 6+7 (Humid)
No.	73	73	100	100
Av. Age	29.6	29.8	29.1	28.9
% Lt.-Wt.	15.1	15.1	8.0	8.0
% Med.-Wt.	76.7	76.7	78.0	78.0
% Hy.-Wt.	8.2	8.2	14.0	14.0
Av. Ht./$\sqrt[3]{\text{Wt.}}$	12.93±.06	12.86±.49	12.61±.70	12.61±.77
Systolic Mean±S.E.	116.14±1.61	116.00±1.47	113.30±1.96	117.40±1.70
Diastolic Mean±S.E.	69.56±1.14	71.07±1.23	67.30±1.04	71.00±1.21
Systolic Range	72–146	90–144	82–190	82–188
Diastolic Range	42–94	40–94	40–96	42–120

The results are shown in table 15. Applying the correct test for significance of difference between matched samples the results are as follows: Male region 4 versus region 6 plus 7 systolic pressure, $t = .221, P > .8$, diastolic $t = .955, P > .3$. Female region 4 versus region 6 plus 7 systolic pressure, $t = 1.720, P > .05$, diastolic $t = 2.371, P > .01$. By the criterion of the 1 per cent level of confidence none of these differences is significant.

Therefore, it would appear that in Puerto Rico the climate of the different regions in question does not seem to influence blood pressure.

However, in view of the fact that the climatic differentiation of the regions is perhaps not marked, the above conclusion should be treated as a tentative one.

H. THE EFFECT OF INTESTINAL PARASITES ON BLOOD PRESSURE

It has been known for a long time that the incidence of intestinal infestation is very high in Puerto Rico. Otero and Perez, using a sample of 8,898 adult male rural agricultural workers, ages 20 to 65 and over, drawn mainly from 48 municipios, have shown that, taking the sample as a whole, 75.8 per cent of all workers had some kind of intestinal parasitic infestation.[49]

The percentage breakdown of the latter is as follows: Uncinaria (hookworm) 91.2, Ascaris 12.1, Trichuris 48.3, Schistosoma 0.2, and Other Intestinal Parasites 0.1.

Weller and Dammin used a sample of 19,139 male Puerto Rican Selective Service registrants, ages 18–38, who were mostly urban and from all municipios, but in what proportion compared to the 1940 Census we are not told.[50] For the total group the incidence of intestinal parasitic infestation was 88.3 per cent. Of those with positive parasites the percentage breakdown is as follows: Hookworm 64.0, Ascaris 7.6, Trichuris 86.4, Schistoma 11.2, Strongyloides Stercoralis 11.7, and Other Intestinal Parasites 0.1.

[49] Otero, Morales P., and M. A. Perez, Health and socio-economic studies in Puerto Rico. IV. Physical impairments of adult life among agricultural workers, *Puerto Rico Jour. Pub. Health and Trop. Med.* **15**: 285–313, 1940.

[50] Weller, T. H., and G. J. Dammin, The incidence and distribution of Schistosoma mansoni and other helminths in Puerto Rico, *Puerto Rico Jour. Pub. Health and Trop. Med.* **21**: 125–147, 1945.

In view of the fact that the first sample is composed of male rural agricultural workers and the second sample is mainly urban, consisting of "relatively healthy and well-educated adult males with proportionately few laborers from the sugar, tobacco, and coffee-farming areas," the difference between the samples in the percentage incidence of hookworm, trichuris, and schistoma is not without interest.

There is a fairly prevalent belief in medical circles that there is a correlation between "low" blood pressure and the infestation of parasites, particularly ascaris or hookworm.[51] This belief is not shared by all as can be seen in the case of Saunders [52] and Torgerson.[53] Because of these conflicting views it was considered to be worth while to test the possible difference between those with and those without intestinal parasitic infestation on blood pressure.

Concerning this point it is worth noting that, regarding intestinal parasites in 1947, I stated,

> One wonders again what could be the effect of such infestation on blood pressure. . . . The time has come to cease wondering.[54] A study on blood pressure should be done, in an area having intestinal parasites, using one group known to be free of the parasites as control, and another group that does have them.

Fecal examinations were done only on part of the total Puerto Rican sample because we were not asked to collect fecal specimens until some time after we had started to collect the main sample, and also many individuals who said they would return with a specimen did not do so.

From 1,509 non-prison males results were obtained on only 501 individuals or 33.2 per cent; 70.5 per cent of the 501 individuals were positive and 29.5 per cent were negative in parasites. From 1,505 females results were obtained on only 603 individuals or 40.1 per cent. 63.8 per cent of the 603 individuals were positive and 36.2 per cent were negative in parasites.

The following methodology was used to obtain the test samples. Random samples of 125 non-prison urban or rural males and 125 urban or rural females who were negative in parasites were first obtained and analyzed in regard to the following variables: age groups 20–44, weight group, nutritional class, and ethnic group. For example, age group 20–24 and subsequent age groups were divided into light-, medium-, and heavy-weight groups, and each weight group analyzed regarding the number in each nutritional class that fell into ethnic groups 0–8. By random sorting male and female positive parasite samples were obtained equal in number to the negative parasite samples, each individual in the former samples being matched with a similar individual in the latter samples.

As far as these positive parasite samples are concerned they represent individuals with any kind of intestinal parasitic infestation, whether single or mixed.

The results are shown in table 16. Applying the correct test for significance of difference between matched samples the results are as follows: Male parasites, positive versus negative systolic pressure, $t = 1.558, P > .1$, diastolic $t = 1.419, P > .1$. Female parasites, positive versus negative systolic pressure, $t = .489, P > .6$, diastolic $t = .163, P > .8$. None of these differences is significant.

TABLE 16

THE EFFECT OF INTESTINAL PARASITES ON BLOOD PRESSURE

	Male		Female	
	Positive parasites	Negative parasites	Positive parasites	Negative parasites
No.	125	125	125	125
Av. Age	30.8	31.5	30.9	31.0
% Lt.-Wt.	21.6	21.6	11.2	11.2
% Med.-Wt.	68.8	68.8	76.0	76.0
% Hy.-Wt.	9.6	9.6	12.8	12.8
Av. Ht./$\sqrt[3]{\text{Wt.}}$	12.85 ± .05	12.90 ± .05	12.50 ± .05	12.57 ± .06

Region	A %	B %	C %	A %	B %	C %
1	5.5	7.2	3.2	5.6	7.2	4.8
2	34.5	24.0	38.4	35.1	16.0	35.2
3	6.7	6.4	3.2	6.5	5.6	4.8
4	19.6	12.8	18.4	19.2	16.0	20.8
5	10.3	11.2	3.2	10.5	16.8	4.8
6	8.3	13.6	12.0	8.2	22.4	11.2
7	15.1	24.8	21.6	14.9	16.0	18.4

A. Calculated Region Distribution.
B. Actual Positive Parasite Distribution.
C. Actual Negative Parasite Distribution.

Systolic Mean ± S.E.	115.75 ± 1.22	118.68 ± 1.36	116.28 ± 1.77	115.84 ± 1.75
Diastolic Mean ± S.E.	71.39 ± .92	73.25 ± 1.04	69.84 ± 1.04	70.08 ± 1.09
Systolic Range	82–152	90–176	80–220	84–194
Diastolic Range	50–98	50–122	44–110	48–112

[51] Heilig, R., The pathological heart conditions in hookworm disease and their causes, *Indian. Med. Gazette* **77**: 257–261, 1942.

[52] Saunders, G. M., Blood pressure in Yucatecans, *Amer. Jour. Med. Sci.* **185**: 843–851, 1933.

[53] Torgerson, W. R., Blood pressure findings in Puerto Rico, *Puerto Rico Jour. Pub. Health and Trop. Med.* **5**: 438–442, 1930.

[54] Murrill, *op. cit.*

Considering the fact that fecal examinations were performed only on a portion of the total Puerto Rican sample, the percentage region distribution of the positive and negative parasite samples, shown in table 16, when compared with the calculated region distribution is encouraging. The main discrepancies are in the male positive parasite sample region 2, and in the female positive parasite sample regions 2 and 6. Caution then is indicated in interpreting the results of the test samples.

Nevertheless, the results of the test samples show that in all probability, whether an individual has an intestinal parasitic infestation or not in Puerto Rico, this has no appreciable effect on blood pressure.

I. SUMMARY AND CONCLUSIONS REGARDING THE MOST IMPORTANT VARIABLES AFFECTING BLOOD PRESSURE IN PUERTO RICO

As far as this general analysis of Puerto Rican blood pressures is concerned the evidence indicates that the most important variables affecting blood pressure are weight groups and possibly age in relation to weight groups.

It has been shown also that in Puerto Rico the following variables exert no appreciable effect on blood pressure: body build, urban or rural life, nutritional class, climate of the two regional areas tested, and intestinal parasitic infestation.

It might be argued by some that the effect of urban or rural life, etc., on blood pressure should have been tested first before coming to any conclusions regarding, say, "normal" blood pressure in Puerto Rico. On the contrary, the effect of the different weight groups on blood pressure is outstanding and this had to be demonstrated first and then incorporated into the various test samples.

It should now be apparent that, if one is going to compare two populations regarding any possible blood pressure differences, certain basic precautions are essential. First, the samples must be as representative as possible of the populations in question. Second, weight groups are important; for example, if one sample has a great preponderance of heavy-weights and the other does not, the former will probably have higher mean systolic and diastolic pressures. Third, although the evidence in Puerto Rico shows that certain variables such as urban or rural life, etc., have no appreciable effect on blood pressure, until additional similar evidence is forthcoming from other areas in the world one cannot as yet ignore these variables, particularly in the case of racial blood pressure studies.

PART II. CRITIQUE OF METHODOLOGY USED IN EXISTENT RACIAL BLOOD PRESSURE STUDIES

GENERAL

A number of individuals have made statements which have an important bearing on the problem of blood pressure studies in general and racial blood pressure studies in particular. In the following quotations I have italicized what I consider to be the key phrases.

For example, Ashley-Montagu [1] has remarked that,

> . . . in medicine the tendency is strongly entrenched to think of the diagnosis and cure of disease in terms of specific knowledge of the meaning of the symptoms and the physical means of alleviating them, *giving little or no thought to the socio-economic factors which produced them and which are likely to cause them to recur. . . . Differences in mortality rates, incidence of different diseases . . . may loosely and uncritically be attributed to the "racial" factor when they usually have nothing whatever to do with it.*

Collumbine *et al.*[2] have stated that,

> The existence of differences in anthropometric measurements and indices between subjects of different racial extraction is well established. *Differences in physiological factors, on the other hand, have been rarely studied.* Since physique and body proportions are known to influence exercise performance ability, we should expect to find racial differences in exercise ability. *The latter, however, can also be affected by environmental factors and the differentiation between environmental and racial influences is always a major difficulty.*

Hueper [3] has indicated that,

> In the determination of race conditioned diseases *it is essential to distinguish sharply between hereditary diseases or dispositions to diseases which, through an exceptional frequency among certain racial groups, show their relationship to racial factors, and those*

[1] Ashley-Montagu, M. F., Physical anthropology, *Medical Physics*, ed. by Otto Glasser, Chicago, Year Book Publishers, Inc., 1944.

[2] Collumbine, H., S. W. Bibile, T. Wikramanayake, and R. S. Watson, The influence of race and environment on physical fitness, *Ceylon Jour. Med. Sci.* **6**: 113–141, 1949.

[3] Hueper, W. C., Racial aspects of arteriosclerosis, *Urol. and Cutan. Rev.* **48**: 336–340, 1944.

diseases which exhibit a high regionary, and, for this reason, also often racially restricted high incidence, but which *are the result of special, non-hereditary, environmental factors related to nutrition, habits, customs, occupation, infections, fauna, flora, social and geologic conditions and age and sex distribution.*

Leman [4] has said that "While previous reports in the literature did suggest that the Chinese have lower blood pressure than the Occidental and that a sojourn causes a lowering of blood pressure in foreigners, it does not follow that this is to be attributed to the effect of climate. *Variables such as race, custom, habit, diet and disease have not been eliminated in these studies.*"

Wu [5] has stated that,

When the averages of two groups of individuals are compared and a difference is found between them, the question immediately arises whether it is due to a difference in heredity or to one in environment. *The morphologist is inclined to assign greater weight to heredity, while the physiologist would emphasize the influence of the environment. It is evident that only by keeping one of the two factors constant can the above question be answered.*

Finally Kruse *et al.*[6] have admonished others as follows,

So long as studies on the same topic are conducted under widely different conditions there will be different and contradictory results . . . understanding of this fact is the first step in reducing the field to order.

Where at least some attempt has been made to avoid the first criticism mentioned above, the results have been apparently quite overlooked as in the case of Moriyama and Herrington.[7] The latter in a study, based on average mortality rates in 44 states of the U.S.A., of the relationship of a *group* of diseases of the circulatory system, including "ideopathic hypertension," to a *group* of climatic variables such as normal temperature, relative humidity, frequency of anticyclones, etc., and a *group* of socio-economic variables such as per cent urban, per capita income, proportion of negroes in the population, etc., found the latter to be of greater statistical significance than the former group of variables.

On the other hand, as will be shown later regarding racial blood pressure studies, it is indeed amazing how consistently the afore-mentioned suggestions have been ignored.

RACIAL BLOOD PRESSURE STUDIES

A. TYPES OF RACIAL BLOOD PRESSURE STUDIES

From the data available on racial blood pressure studies it is apparent that these studies fall into three main categories.

1. *Studies of Separate Racial Groups*

Here one usually finds that the mean blood pressures are given either for the total group or by age group. The mean pressures are often not accompanied by their standard errors. Little else is obtainable from such a study, for an example of which see de Lima.[8]

2. *Studies of the Comparison of Two Racial Groups*

Probably the majority of studies made so far fall into this category, such as a West Indian (Negroid) and Mongoloid comparison,[9] or a Mongoloid and American (Caucasoid) comparison,[10] or a Negroid and American (Caucasoid) comparison.[11] The latter type will be treated separately in this study in Part III. It is in this general category of studies that certain important variables, such as weight groups, etc., which might affect blood pressure have not been held constant; consequently the conclusions proffered by the various authors are highly suspect. A typical example of such a study will be criticized later.

[4] Leman, I. I., The effect of long continued subtropical summer on high blood pressure, *Amer. Jour. Trop. Med.* **12**: 331–347, 1932.

[5] Wu, H., Heredity, environment and physiological average, *Chinese Jour. Physiol.* **1**: 187–195, 1928.

[6] Kruse, H. D., A. Bessey, N. Joliffe, J. S. McLester, F. F. Tisdall, R. M. Wilder, and V. P. W. Sydenstricker, Principles underlying studies of nutrition pertaining to the influence of supplements on growth, physical fitness and health, *Arch. Int. Med.* **74**: 258–279, 1944.

[7] Moriyama, I. M., and L. P. Herrington, The relation of diseases of the cardiovascular and renal systems to climatic and socio-economic factors, *Amer. Jour. Hyg.* **28**: 423–436, 1938.

[8] de Lima, P. E., Blood pressure levels of Kalapalo and Kamaiurá Indians, *Revista Brasileira de Medicina* **7**: 787–788, 1950.

[9] Kean, B. H., Blood pressure studies on West Indians and Panamanians living on the Isthmus of Panama, *Arch. Int. Med.* **68**: 466–475, 1941.

[10] Foster, J. H., Blood pressure of foreigners in China, *Arch. Int. Med.* **40**: 38–45, 1927.

[11] Schwab, E. H., and V. E. Schulze, Heart disease in the American negro of the South, *Amer. Heart Jour.* **7**: 710–717, 1931–1932.

3. *Comparative Study of Many Racial Groups*

To my knowledge only one such study exists, that of Kean and Hammill.[12] This study lists mean blood pressures by age group of the then existent racial blood pressure studies, and attempts but fails to give a satisfactory answer to two main questions, namely, "Is the rise of blood pressure with age physiologic or pathologic?" and "Is civilization or the so-called civilizing influence responsible for an increase of arterial tension?" It is interesting to note that these authors found in this comparative study that poor Chinese have low arterial tension and no increase with age, whereas wealthier Chinese have a higher average blood pressure in each age group and a moderate increase with age. Yet in their conclusions they state that economic status is not a significant factor in the genesis of hypertension!

Apart from the latter inconsistency the authors are not able to reach any other definite conclusions simply because the methodology used in existent racial blood pressure studies is so immensely bad.

In regard to racial blood pressure studies table 17 indicates the main ones which I have been able to unearth. It will be noted that in this table the studies are grouped according to geographic area. Column A refers to those studies pertaining to racial blood pressure and includes some studies containing data on weight groups, etc., particularly from China. Column B refers to those studies in which the methodology is of such a nature that one can probably put them in the racial cate-

TABLE 17

RACIAL BLOOD PRESSURE STUDIES
1907–1953

	Studies pertaining to racial blood pressure A	Racial blood pressure studies B	% of total of B by area C
North America			
1. Mongoloid. Eskimo.	6	4	
2. Mongoloid. Ojibwa, Sioux, Chippewa, Navaho, Zufii.	7	1	
3. Negroid and Mixed Caucasoid Comparisons.	16	3	16
Central America			
1. Mongoloid. Mestizo, Mexico, Maya, Guatemala.	5	4	
2. Mongoloid and Negroid Comparisons, Panama.	3	1	10
West Indies			
1. Caucasoid, Mixed Caucasoid-Negroid, Negroid. Puerto Rico.	5	3	
2. Negroid. Virgin Islands.	1	1	
3. Mongoloid. Cuna, San Blas Archipelago, Panama.	1	1	10
South America			
1. Mixed Caucasoid?			
Brazil	1	1	
Chile	1	—	
Argentine	2	2	
2. Mongoloid. Kalapalo, Kamaiurá, Brazil.	1	1	8
Africa			
1. Mixed Caucasoid. Egypt.	2	1	
2. Negroid.			
Belgian Congo	1	1	
Kenya	2	2	
Uganda	1	1	
Union of S. Africa	2	—	10
Syria			
1. Mixed Caucasoid. (Arab?)	1	1	2
India			
1. Mixed Caucasoid.			
Bengal	1	1	
Punjab	1	1	
N., E., and S. India	1	1	
N. India	1	1	
Upper Assam	1	1	10
Ceylon			
1. Mixed Caucasoid and Mongoloid.	1	1	2
Malay States			
1. Mixed Mongoloid.	1	1	2
China			
1. Mongoloid.			
Anthropometric and general data	14	—	
N. China	1	1	
C. China	3	3	
S. China	3	3	
N., C., and S. China	1	1	16
Formosa			
1. Mongoloid.	1	1	2
Japan			
1. Mongoloid.	2	2	4
Philippines			
1. Caucasoid.	4	—	
2. Mixed Mongoloid.	2	2	4
Micronesia			
1. Mongoloid-Negroid-Caucasoid Mixture. Ponape.	1	1	2
Australia			
1. Australian Aboriginal. Carpentarian? Cape York Peninsula, Queensland.	1	1	2
	98	50	100

References for B are marked with an asterisk under the heading, Geographical Areas, in the bibliography at the end of this study.

[12] Kean, B. H., and J. F. Hammill, Anthropathology of arterial tension, *Arch. Int. Med.* **83**: 355–362, 1949.

gory. It is interesting to observe that the total for column B is only 50 studies from the year 1907 to 1953. Also column C shows that the studies are concentrated in the geographic areas of the Americas, Africa, India, and China. It is of even greater interest that of all the studies indicated in column B, with the exception of the present study, not one is really methodologically sound.

B. PONDERAL INDICES, WEIGHT GROUPS, AND THEIR RELATIONSHIP TO RACIAL BLOOD PRESSURE STUDIES

Before giving any specific examples of poor methodology in racial blood pressure studies it is necessary, in order really to understand the poor methodology, to linger for a moment upon the subject of ponderal indices and weight groups.

It is a most unfortunate fact that those responsible for gathering anthropometric data, and blood pressure, have so often omitted the measurement of weight. Without weight of course one cannot calculate a ponderal index. However, basal metabolism studies are a rewarding source for obtaining both height and weight measurements and hence ponderal indices. But the latter studies seldom include blood pressures, so that more often than not one is caught between the devil and the deep blue sea.

In spite of this predicament it is possible to obtain a certain amount of indirect though useful information. For example, table 18 indicates the mean ponderal indices of various samples from different geographic areas. These indices are indirect ones, that is to say, were obtained by dividing the mean weight by the mean height. Column

TABLE 18

MEAN PONDERAL INDICES OF VARIOUS SAMPLES FROM CHINA, MICRONESIA, AFRICA AND THE U.S.A.

Author	Location	Sex	No.	Av. age	Av. wt. (lbs.)	Av. ht. (cms.)	Mean ponderal index	
							A Wt. (lbs.)/ Ht. (ins.)	B Wt. (lbs.)/ Ht. (cms.)
Stevenson (1925)	N. China	Male	1,240	20+	130.5	169.0	1.96	.77
	C. China	Male	1,056	20+	113.5	164.6	1.75	.69
	S. China	Male	967	20+	111.1	163.3	1.72	.68
	S. China	Female	175	22+	101.2	151.4	1.69	.67
Tung (1928)	N. China	Female	63	20–30	110.0	155	1.80	.71
	C. China	Female	62	20–30	105.6	154	1.74	.68
	S. China	Female	19	20–30	105.6	155	1.73	.67
Kilborn (1937)	W. China	Male	37	25.7	113.8	164.9	1.75	.69
Kilborn and Benedict (1937)	S.W. China	Male	24	36.5	102.0	154	1.68	.66
Siddall (1937)	S. China	Female	69	20–40	97.6	155.9	1.59	.62
Murrill (1947)	Micronesia, Ponape	Male	130	38.8	130.2	163.2	2.02	.80
		Female	127	36.3	112.8	151.6	1.89	.74
(1948–9)	W. Indies, Puerto Rico	Male	1,903	29.5	129.6	164.3	2.00	.79(.79*)
		Female	1,505	29.6	104.3	152.7	1.73	.68(.72*)
Orr and Gilks (1931)	Africa, Kenya							
	Kikuyu	Male	1,576	26.0	112.1	163.8	1.73	.68
	Masai	Male	379	27.7	131.8	171.7	1.94	.76
Robinson and Brucer (1940)	U.S.A., Chicago	Male	7,478	38.8	—	173.7	2.31*	—
		Female	2,325	37.1	—	161.5	2.19*	—

* Correctly calculated value.

A is the ponderal index of Robinson and Brucer [13] and column B the ponderal index used by myself in the present study.

These indices indicate two main points quite clearly. First, within one geographic area such as China, for male and female, the mean ponderal indices are higher in the north than in the south of China. Presumably, if the total sample is sufficiently large, a higher mean ponderal index indicates a higher proportion of heavy-weights. Second, comparing males, say, in different geographic areas such as Southern China, Puerto Rico, and Chicago, U.S.A., the mean ponderal index *increases*.

It is not my purpose here to explain fully why these differences exist, although—*en passant*—one would immediately think of differences in nutrition and/or degree of urbanization, but merely to point out that the differences do exist and that obviously in regard to mean ponderal indices it would make a considerable difference as to where one obtained a sample.

In regard to the latter point it is worth while noting that ponderal indices, based on the formula weight in pounds/height in inches, and obtained from World War I U.S. Army males,[14] show that the lowest indices came in general from the southern states, particularly such areas as the mountain regions of Tennessee, North Carolina, Kentucky, Virginia, and Arkansas, in other words low socio-economic areas. Not only are the indices from these areas the lowest of all the states, i.e., 2.05–2.07, *but the latter are higher than the indices for Northern Chinese males.*

Since the ponderal index is the basic tool for delineating weight groups, the relationship of the latter to mean blood pressures in different geographic areas is of great importance. However, one is immediately faced here with a fundamental problem, namely, for the purposes of this study, what mean ponderal index shall we use to delineate weight groups? Will it be one based on an unrepresentative but presumably nutritionally "adequate" sample, such as that of Robinson and Brucer's Chicago, U.S.A. sample,[15] or will it be one based on a definitely representative but presumably nutritionally "inadequate" sample, such as the Puerto Rican sample in Part I of this study? In view of the basic importance of representative samples the latter course is safer at this stage.

Table 19 indicates the mean blood pressure results in three samples, by weight groups, based on the Puerto Rican mean ponderal index. The Chicago, U.S.A., sample results are only approximations since the original data were based on the ponderal index formula of weight in pounds/height in inches. Compared to the Puerto Rican sample the percentage proportions of the weight groups in the three samples differ. On the other hand the mean blood pressures by weight group are in general fairly similar. This illustrates the important point that it is the proportion of weight groups, particularly the heavy-weight group, within any sample that will affect the mean blood pressures for the total weight groups. If one sample is used as the standard and another sample has a much smaller proportion of heavy-weights and a much larger proportion of light-weights, then the latter sample will probably have lower mean blood pressures taking all the weight groups together.

This is essentially what has occurred almost invariably in the literature on racial blood pressure. A racial group sample is compared, regarding its mean blood pressures for the total

TABLE 19

COMPARISON OF MEAN BLOOD PRESSURES OF MALES ONLY BY WEIGHT GROUP IN THREE GEOGRAPHIC AREAS

	Lt.-Wt.	Med.-Wt.	Hy.-Wt.	All Wts.
Puerto Rican Sample (Murrill)				
Ponderal Index Range	<.69	.69–.89	>.89	
No.	247	1,401	255	1,903
%	13.0	73.6	13.4	100.0
Systolic Mean ±S.E.	111.31 ±.92	115.91 ±.39	122.74 ±.93	116.24 ±.34
Diastolic Mean ±S.E.	67.47 ±.66	70.47 ±.29	76.90 ±.68	70.94 ±.25
Chesterfield Inlet Eskimo Sample (Crile and Quiring)				
No.	2	14	14	30
%	6.6	46.7	46.7	100.0
Systolic Mean ±S.E.	108.00(±8.51)	117.35 ±4.07	121.30 ±3.74	118.65 ±2.71
Diastolic Mean ±S.E.	71.50(±3.16)	72.70 ±2.71	78.05 ±2.08	75.20 ±1.69
U.S.A. Chicago Sample (Robinson and Brucer)				
No.	91	3,863	3,524	7,478
%	1.2	51.7	47.1	100.0
Systolic Mean	116.00	118.38	124.04	121.00
Diastolic Mean	69.00	72.38	76.92	74.00

[13] Robinson and Brucer, *op. cit.*

[14] Medical department of the U. S. Army in the World War. Statistics. Part I. Army Anthropology, *U. S. Surgeon-General's Office* **15**: 1–635, 1921.

[15] Robinson and Brucer, *op. cit.*

sample, with a sample such as the Robinson and Brucer one, i.e., a U. S. insurance company urban white sample. The mean blood pressures of the former are found to be lower than those of the latter sample, hence the difference is attributed to "race," whereas from the point of view of weight group proportions the samples were not comparable in the first place.

It can now be seen that the question of which mean ponderal index should be used for *future blood pressure studies,* racial or otherwise, is a vital one and doubtless rests upon the obtaining of as representative a sample as possible of a population which has as "adequate" a nutrition as possible.

It is only fair to say, however, that not all of the investigators of racial blood pressure have been completely caught in the above methodological trap. Unfortunately their advice has passed unheeded. For example, Williams, using an Eastern Uganda negro sample, but without using weight groups, came to the conclusion that when discussing racial groups, in regard to mean blood pressures, weight and physique have a greater significance than has so far been appreciated.[16]

Ling, using a sample from North, Central, and South China, but unfortunately excluding those individuals considerably under- and over-weight, and in general those with a systolic pressure below 90 or over 140, and a diastolic pressure below 60 or over 100, nevertheless is aware of the importance of the weight factor.[17] He shows quite clearly that if those Chinese who are 20–40 per cent below and above the Chinese age-height-weight average are grouped together, then the mean systolic and diastolic blood pressures in every age group from 20–24 to 55–59 in the under-weight group are below those in the corresponding age group of the over-weight group. In the under-weight group from the age group 20–24 to 55–59 also the mean blood pressures do not rise perceptibly.

He then separates the sample into North, Central, and South China. In this case the mean blood pressures are for all weight groups. However, for each age group from 20–24 to 55–59 the mean pressures are higher for the Northern than Southern Chinese. Ling points out that in the Northern Chinese over-weight individuals are 2.6 times as numerous as under-weights, whereas in the Southern Chinese under-weight individuals are 2.4 times as numerous as over-weights.

Finally Ling wonders whether a difference in weight, i.e., under-weight, might not explain racial variation in blood pressure. In view of the fact that this study was published in 1936 it is astounding how consistently its implications concerning the weight factor have been disregarded in racial blood pressure studies. Regarding this point I might add, somewhat belatedly, that I, too, am not innocent of the justifiable accusation of "Et tu, Brute," in my 1947 study on the blood pressure of the Ponapeans.[18]

C. GENERAL EXAMPLES OF THE POOR METHODOLOGY IN RACIAL BLOOD PRESSURE STUDIES

A few racial blood pressure studies have been selected at random as rather typical examples of employing poor methodology. As a matter of fact almost all the existent racial blood pressure studies have made one or more of the following errors.

1. *Method of Taking Blood Pressure*

This varies from the standing or sitting to the lying down position, the latter being employed by Ying.[19] Consistency is necessary here. Blood pressures should be taken in the sitting position and by the auscultatory method.

2. *Non-representative Samples*

This is a universal fault. One cannot accept as representative samples those in which (*a*) the total number amounts to 14 Egyptians—Alam and Smirk;[20] (*b*) the Ceylonese group selected includes only those subjects who could perform certain physical fitness tests—Bibile *et al.*[21]

[16] Williams, A. W., The blood pressure of Africans, *East African Med. Jour.* **18**: 109–117, 1941–1942.

[17] Ling, W. K., The blood pressure of the Chinese. Statistical study of 20,948 life insurance applicants, *Chinese Med. Jour.* **50**: 1773–1798, 1936.

[18] Murrill, *op. cit.*

[19] Ying, Y. Y., Blood pressure of healthy individuals in Shaoing, *China Med. Jour.* **40**: 641–644, 1926.

[20] Alam, G. M., and F. H. Smirk, Casual and basal pressures in British and Egyptian men, *Brit. Heart Jour.* **5**: 152–155, 1943.

[21] Bibile, S. W., H. Collumbine, C. Kirtisinghe, R. S. Watson, and T. Wikramanayake, The variation, with age and sex, of blood pressure and pulse rate, for Ceylonese subjects, *Ceylon Jour. Med. Sci.* **6**: 79–82, 1949.

3. *Combining Male and Female Blood Pressure Results*

Some authors still continue to make this error —Hudson and Young.[22]

4. *Using Only a Portion of the Blood Pressure Results*

For example, using a delimited group of systolic and diastolic pressures among Eskimos, that is to say using no systolic or diastolic pressures over 129 and 82, without also giving mean pressures for *all* the pressures in the total sample—Levine.[23]

5. *No Control of Important Variables*

Again this is an almost universal and fundamental mistake, i.e., (*a*) attributing Chinese blood pressure differences of those living in China and those living in Canada to climate without equating weight groups—Krakower;[24] (*b*) comparing various racial groups whose diets, weights, and climatological residence time differ—MacGregor and Loh.[25]

6. *Persistence of Stereotypic Conclusions Based on Faulty Methodology*

For example, referring to the Mexican Indian as an individual who does not suffer from psychasthenia, hence this may explain his relative freedom from hypertension—Chavez.[26]

The above examples are of a general nature. It is now time to be more specific in regard to a particular study.

D. CRITICISM OF A PARTICULAR RACIAL BLOOD PRESSURE STUDY

The racial blood pressure study selected in this case is that of Shattuck, because it combines rather nicely the usual methodological errors.[27] However, I hasten to point out that this particular study is much better than most other similar studies, which should give some indication of the methodological level of racial blood pressure studies in general.

In the study in question the methodological errors will be criticized under the following headings.

1. *Sample*

A sample of male and female Guatemalan and Yucatecan Indians is used. No proof is presented of the representativeness of the sample. Individuals used are from ages 10 to over 70. Individuals aged 10–17 are of course too young and should not be included.

2. *Blood Pressure Results*

The Guatemalan Indians are described as being of two types, namely, mixed Spanish-Indian and pure Indian. In the main table of blood pressure results both types and both sexes are combined!

3. *Standard for Blood Pressure Comparison*

The standard used is the North American insurance company sample of Symonds.[28] Ninety-five per cent of this sample was probably made up of individuals from, in, and around New York City, and is scarcely representative of blood pressures in the U.S.A.

4. *Factors Influencing Systolic Blood Pressure*

a. Age

Shattuck's mixed weight group and sex, Guatemalan Indian mean blood pressure results show an increase with age. No standard errors are given, weight groups are mixed; therefore the significance of the rise cannot be evaluated.

b. Weight and height

The Guatemalan blood pressure results, by age group, are compared with those of Symonds' build groups 0 and 8. The basis of the latter is "the average weight of men for each inch of height at the age of 37"(?). Build group 0 includes those

[22] Hudson, E. H., and A. L. Young, Medical and surgical practice on the Euphrates river. An analysis of 2000 consecutive cases at Deir-Ez-Zor, Syria, *Amer. Jour. Trop. Med.* **11**: 297–310, 1931.

[23] Levine, V. E., The blood pressure of the Eskimo, *Federation Proc.*, part 2, **1**: 121, 1942.

[24] Krakower, A., The blood pressure of Chinese living in Eastern Canada, *Amer. Heart Jour.* **9**: 396–404, 1934.

[25] MacGregor, R. G. S., and G. L. Loh, The comparison of basal physiological values in racial groups. Part I. Metabolism, pulse rate and blood pressure, *Jour. Malaya Br. Brit. Med. Assn.* **4**: 217–260, 1940–1941.

[26] Chavez, I., The incidence of heart disease in Mexico, *Amer. Heart Jour.* **24**: 88–98, 1942.

[27] Shattuck, G. C., The possible significance of low blood pressures observed in Guatemalans and in Yucatecans, *Amer. Jour. Trop. Med.* **17**: 513–537, 1937.

[28] Symonds, *op. cit.*

individuals who are 5 per cent below and above standard weight, and build group 8 those individuals who are 25–35 per cent below standard weight.

The Guatemalan pressures were lower than those of both Symonds' build groups; therefore, the author concludes that build group is not an important factor. Interestingly enough this is one of the few attempts made in the literature to compare blood pressures of similar weight groups. Unfortunately, the comparison is invalid because the Guatemalan sexes are mixed and one standard is used for determining weight or build groups for the Symonds' sample, and no standard at all for the Guatemalan sample; in fact all the Guatemalans are assumed to be light-weight!

c. Race

The Guatemalans are then compared with various other samples such as, among others, Filipinos (mostly convicts)—Concepcion and Bulatao,[29] and East African negroes—Donnison.[30] The author then makes the following statement,

> It appears . . . that markedly low levels of blood pressure have been observed in certain groups of the white race, the yellow race and the "red" race, but that other groups of the white race and of the red race, and a group of the black race in Africa have shown blood-pressure levels which are equal to the standard accepted as normal.

No other statement could indicate so clearly the fallacy of not equating weight groups or using a dubious standard for blood pressure comparison.

d. Nutrition and diet

The author points out that little meat and mostly rice is eaten in China where pressures are low, and also little meat is eaten by Filipinos where again pressures are low. However, a nutritious diet and low pressures are seen in the Filipino constabulary. Yucatecan Indians have a poorer diet than Guatemalan Indians, yet blood pressure levels by age group are higher for Yucatecan Indians. Finally he notes correctly that North Americans may over-eat for the higher the weight group the higher the pressure. However, the significance of the latter, in regard to equating diet and weight groups properly in racial blood pressure studies, seems to have escaped the author.

e. Climate

Yucatecan Indians have higher pressures than Guatemalan Indians, yet the latter live in a more warm-temperate climate due to a higher altitude! In the tropical *and* temperate parts of China pressures are low! This evidence the author finds is conflicting. Indeed it is as long as important variables are not equated.

5. General Conclusions

The author concludes that it is very hard to evaluate all the variables of age, sex, weight and height, nutrition and diet, climate and altitude. *Perhaps, but it is not impossible to do so, as has been shown in the Puerto Rican sample in Part I of this study.* Furthermore, the above variables must first be evaluated before one concludes, as does Shattuck in his study, that low blood pressures seem not to be attributable to sex, weight and height(?), altitude and climate, and are perhaps due to racial characteristics, a slow tempo of life or a possibly deficient diet.

E. METHODOLOGY PROPOSED FOR DETERMINING THE POSSIBLE EXISTENCE OF RACIAL BLOOD PRESSURE DIFFERENCES

In view of the examples of poor methodology indicated in sections C and D above, it is now clear that the time is ripe for proposing an efficient methodology, such as the following.

1. Homogeneity of Racial Groups

If one is going to investigate the effect of race on blood pressure then one should select say two racial stocks, for example negroid and caucasoid. It is not enough to say that one group is negro and the other white—the usual case in the existing literature. In addition some proof must be given of a morphological and blood gene frequency nature, if possible, of the relative homogeneity of each racial group in question.

2. Representative Samples

The samples used must be as representative as possible of the racial groups in the geographical area being examined. Each total sample should contain not less than 100 individuals, naturally of the same sex.

[29] Concepcion, I., and E. Bulatao, Blood pressure picture of the Filipino, *Philippine Jour. Sci.* **11**: 135–149, 1916.

[30] Donnison, C. P., Blood pressure in African native; its bearing upon aetiology of hyperpiesia and arteriosclerosis, *Lancet* **1**: 6-7, 1929.

3. *Importance of Equating Variables*

Each racial group is subject to the possible effect on blood pressure of a number of important variables. Therefore, in order to keep the effect of these variables constant each racial group must have a similar background, that is to say they should be similar in regard to such variables as: (*a*) age structure; (*b*) weight group proportions, based on the same mean ponderal index; (*c*) climatological region—each individual in the samples must come from the same region; (*d*) nutritional class; (*e*) socio-economic class, i.e., *all* the individuals in the samples might be laborers; (*f*) urban or rural—if the population is predominantly rural then all individuals used in the samples can be rural.

4. *Purpose of Using Such a Methodology*

Until such a methodology is followed, or one similar to it, an example of which will be given in Part III of this study, no reliable conclusions regarding the effect of race on blood pressure will be possible.

PART III. METHODOLOGY USED IN DETERMINING THE POSSIBLE EXISTENCE OF BLOOD PRESSURE DIFFERENCES IN TWO SPECIFIC RACIAL SAMPLES IN PUERTO RICO

GENERAL

Since the racial blood pressure comparison in Part III of this study will concern a negro and white sample, and since most similar comparisons have been made on samples obtained in the U.S.A., the nature of the methodology used in the latter should be indicated.

In all the negro-white blood pressure comparisons in the available literature no proof of any kind is given of the racial homogeneity of either the negro or white sample.

In the majority of the comparisons the representativeness of each sample is extremely faulty. There has been a marked propensity for gathering hospital samples, in most of which blood pressure differences are only part of a total cardiovascular picture, i.e., Wood, Jones and Kimbrough,[1] or Burch.[2]

In all the comparisons no effort has been made to equate weight groups or other important variables possibly affecting blood pressure; hence one cannot accept the usual conclusion that negroes have higher blood pressures than whites—Adams.[3]

However, in all fairness to those who have investigated the racial incidence of different diseases —and some regard hypertension as a disease—it is clear that some authors have been cautious in their conclusions. For example, Hedley[4] found that, in the states investigated, negroes aged 5–24 had a higher incidence of rheumatic heart disease. But rheumatic fever appears to follow closely the epidemiology of leucolytic streptococcus infections, such as otitis media, tonsillitis, or pharyngitis. The author hints that the latter may be due to poor socio-economic or public health factors, to which the negro is subject; hence invoking a racial explanation may be invalid.

Gilbert and Gillman[5] have pointed out that, in South Africa, Bantus, compared to whites, have a higher incidence of cirrhosis of the liver and tuberculosis. On the other hand gallstones, diabetes, and peptic ulcer, the latter especially in rural Bantus, are rare. Among Bantus recruited for gold mine work from native territories primary carcinoma of the liver, rare in Europeans, accounted for 90.5 per cent of all cases of cancer. However, the majority of the Bantu workers earned extremely low wages and lived on the cheapest available carbohydrate, namely maize or mealie meal, supplemented in some areas with fermented cow's milk.

The authors fed liberal quantities of corn pap and fermented milk to a Lister strain of 125 albino rats for two years. Without exception the rats developed liver lesions varying from marked fatty changes to multi-lobular cirrhosis. In all the male rats the testes were damaged, and in those rats with severe liver damage the heart was enlarged, and in the majority of rats lung lesions occurred. Therefore, widespread lesions resulted from feeding the common Bantu diet to rats. The authors conclude that this evidence throws a new light on the problem of liver, lung and heart disease in the negro of South Africa, and that great caution

[1] Wood, J. E., T. D. Jones, and R. D. Kimbrough, The etiology of heart disease. A clinical study of 623 cases with certain observations on race and climate, *Amer. Jour. Med. Sci.* **172**: 185–194, 1926.

[2] Burch, G. E., A study of the incidence of coronary occlusion and angina pectoris in the white and negro races, *Amer. Jour. Med. Sci.* **198**: 685–690, 1939.

[3] Adams, J. M., Some racial differences in blood pressures and morbidity in a group of white and colored workmen, *Amer. Jour. Med. Sci.* **184**: 342–350, 1932.

[4] Hedley, O. F., Trends, geographical and racial distribution of mortality from heart disease among persons 5–24 years of age in the United States during recent years (1922–36), *Pub. Health Report* **54**: 2271–2297, 1939.

[5] Gilbert, C., and J. Gillman, Diet and disease in the Bantu, *Science* **99**: 398–399, 1944.

must be exercised in attributing to a racial factor any differences in incidence of disease amongst black and white people.

Finally I wish to draw attention to certain remarks made by Kroeber, particularly because the remarks appear in his excellent textbook on anthropology which has been presumably widely read by anthropologists, although not in general, I fear, by medical doctors.

Kroeber states that "There is undoubtedly more hypertension—excessive blood pressure—in American Negroes than in whites, but this falls in the realm of pathology and its cause is in dispute." [6] Obviously Kroeber's statement is based upon existent negro-white comparisons, the methodological nature of which has already been indicated.

In view of this fact one cannot accept his statement. Interestingly enough, when writing later about specialties of negro pathology, he does not elaborate any further on the subject of hypertension except to reproduce a table from Lewis [7] in which the higher incidence for negroes of hypertension is listed under the heading "Difference perceptible, some probability of being racial."

Of greater importance, however, is another statement by Kroeber concerning the higher incidence of cancer in whites than negroes in the U.S.A. After pointing out that the negro population in the U.S.A., compared to the white, is poorer and less educated, has a more haphazard medical certification of the cause of death, and that it tends to be rural, he states,

> In short, what superficially seems to be a notable race difference in cancer liability and mortality turns out to be at least in part due to natural and socio-cultural environment. This is not an assertion that race has nothing to do with the disease—only that the degree of influence of race has not yet been reliably defined and is difficult to define. The variable x of race and the variable y of environment both remain undetermined; but until we can strip off a fairly determinate result of y influence, we are not even coming to grips with the x factor.

In a word—precisely! The following sections will constitute an endeavor to follow his suggestion.

ANALYSIS OF POSSIBLE BLOOD PRESSURE DIFFERENCES IN A NEGRO AND WHITE SAMPLE

A. METHOD OF OBTAINING THE SAMPLES

Both the negro and white samples used in this study were obtained from the same climatological

[6] Kroeber, A. L., *Anthropology*, Chapter 5, sections 83, 84 and 85, New York, Harcourt, Brace and Co., 1948.

[7] Lewis, J. H., *The biology of the negro*, Chicago, Univ. of Chicago Press, 1942.

TABLE 20

CENSUS SOURCE OF NEGRO AND WHITE SAMPLES

Municipio	1940 Pop'n 20–44	1940 % 20–44	1940 Negro % 20–44	1948 Total Pop'n	1948 Pop'n 20–44 (C×E)	1948 % Rural	1948 20–44 Rural (G×F)	1948 20–44 Rural N (D×H)	1948 20–44 Rural W (H−I)	1948 Male Negro (1/2 I)	1948 Male White (1/2 J)
A	B	C	D*	E	F	G	H	I	J	K	L
Arecibo	24,390	35.25	13.4	80,957	28,537	54.4	15,524	2,080	13,444	1,040	6,722
Barceloneta	6,175	33.30	13.8	20,768	6,916	90.5	6,259	864	5,395	432	2,698
Manati	9,501	32.35	15.9	32,587	10,542	87.0	9,172	1,458	7,714	729	3,857
Vega Baja	7,441	32.21	29.3	23,358	7,524	70.6	5,312	1,556	3,756	778	1,878
Vega Alta	4,381	30.57	32.0	15,978	4,884	79.2	3,868	1,238	2,630	619	1,315
Dorado	3,128	32.99	56.6	11,038	3,641	82.0	2,986	1,690	1,296	845	648
Toa Alta	4,138	30.95	20.0	14,075	4,356	92.8	4,042	808	3,234	404	1,617
Toa Baja	3,880	34.01	42.4	13,787	4,689	82.7	3,877	1,644	2,233	822	1,117
Cataño	3,535	36.37	29.8	12,392	4,507	19.5	879	262	617	131	309
Bayamon	12,463	33.51	21.4	46,783	15,677	65.9	10,331	2,211	8,120	1,106	4,060
Guaynabo	6,246	34.10	24.7	24,222	8,260	95.8	7,913	1,955	5,958	978	2,979
Carolina	7,724	32.12	53.1	29,200	9,379	80.7	7,569	4,019	3,550	2,010	1,775
Loiza	7,115	32.13	50.5	24,430	7,849	64.7	5,078	2,564	2,514	1,282	1,257
Rio Grande	5,126	31.81	41.3	16,800	5,344	84.5	4,516	1,865	2,651	933	1,326
Total										12,109	31,558

* D. Obtained fr m 16th Census of the U. S., 1940. Puerto Rico, Bulletin No. 2, Characteristics of the Population, Table 18.

area in Puerto Rico, namely Region 2 which is subhumid to humid.

Individuals were from rural areas entirely of the following municipios: Arecibo, Barceloneta, Manati, Vega Baja, Vega Alta, Dorado, Toa Alta, Toa Baja, Cataño, Bayamon, Guaynabo, Carolina, Loiza, and Rio Grande. Rio Piedras being mainly urban and San Juan entirely so, these municipios were omitted.

Both samples consist of 126 males, 84 of which were individuals who had lived all their lives in rural areas and were therefore non-prisoners. Forty-two individuals of each sample were prisoners who had lived all their lives in rural areas up to the time of their imprisonment. The average duration in prison in months for the 42 negroes was 16.0 and for the whites 16.4.

The main reason for using prisoners is that the main Puerto Rican sample contains prisoners from various municipios, and considering the time allotted for this research, in order to get a large enough sample, it was absolutely necessary to use them. The prisoners were obtained mainly from the Rio Piedras penitentiary, the San Juan and the Arecibo prisons. The exact proportion of the prisoners from each prison is unimportant since an effort was being made to obtain municipio representation.

Most of the white non-prisoners were obtained from the main Puerto Rican sample, whereas most of the negro non-prisoners and remaining white non-prisoners were obtained in such places as health centers, schools (parents), or the equivalent of villages. This was necessary because not enough white non-prisoners and negro non-prisoners particularly existed in the main sample for the purposes of this study. Again the exact proportions are not important. What is important is the actual representativeness of each total sample in terms of the negro and white rural population of the municipios used in Region 2.

B. REPRESENTATIVENESS OF THE SAMPLES

Table 20 indicates the census source for the negro and white samples. Columns A to F, excluding D, can also be seen in table 1 of this study. Columns G to J are self-explanatory. Since only males were used, in order to obtain the theoretical or calculated samples shown in columns K and L, the results for each municipio in columns I and J were halved.

Table 21 shows the calculated negro and white samples obtained from columns K and L of table 20, reduced to the basis of a sample containing 126 individuals. It also shows the actual non-prison plus prison negro and white samples. It can be seen immediately that the similarity between the calculated and actual samples is indeed close. In fact the average per cent calculated-actual sample difference for the negroes is 2.0 and for the whites 2.3.

TABLE 21

NEGRO AND WHITE SAMPLES

Municipio	Negro				White			
	Calculated		Actual		Calculated		Actual	
	No.	%	No.	%	No.	%	No.	%
Arecibo	11	8.7	8	6.3	27	21.4	36	28.6
Barceloneta	4	3.2	2	1.6	11	8.7	9	7.1
Manati	8	6.3	4	3.2	15	11.9	12	9.5
Vega Baja	8	6.3	6	4.8	8	6.3	10	7.9
Vega Alta	6	4.8	2	1.6	5	4.0	6	4.8
Dorado	9	7.1	10	7.9	3	2.4	2	1.6
Toa Alta	4	3.2	2	1.6	6	4.8	4	3.2
Toa Baja	9	7.1	11	8.7	5	4.0	6	4.8
Cataño	1	.8	1	.8	1	.8	1	.8
Bayamon	12	9.5	14	11.1	16	12.7	20	15.9
Guaynabo	10	7.9	15	11.9	12	9.5	5	4.0
Carolina	21	16.7	27	21.4	7	5.6	6	4.8
Loiza	13	10.3	15	11.9	5	4.0	8	6.3
Rio Grande	10	7.9	9	7.1	5	4.0	1	.8
Total	126		126		126		126	

I particularly want to stress the fact that as far as the male negro and white rural population of the municipios in question is concerned, one can safely assume that the negro and white samples used in this study are definitely representative. As far as I am aware, this is the first time in any negro-white blood pressure comparison that any real proof *has* been shown of the representativeness of the negro and white samples.

C. PROOF OF THE RACIAL HOMOGENEITY OF THE SAMPLES

For the main Puerto Rican sample an "ethnic factor" was devised. The latter has been explained in Part I, under Method, section 3. All of the individuals in the white sample fell into ethnic groups 1–3, whereas all of the individuals in the negro sample fell into ethnic groups 6–8. Since some may feel that this system does not tell one what the actual morphological characteristics of the two samples were, table 22 remedies this situation.

TABLE 22

MORPHOLOGICAL CHARACTERISTICS OF THE NEGRO AND WHITE SAMPLES

Negro			White		
Scale	No.	%	Scale	No.	%
Skin Color (Von Luschan Scale)					
20	2	1.6	10	2	1.6
21	2	1.6	11	10	7.9
22	19	15.1	12	14	11.1
23	15	11.9	13	20	15.9
24	19	15.1	14	23	18.3
25	24	19.0	15	33	26.2
26	31	24.6	16	24	19.0
27	13	10.3			
28	1	.8			
	126	100.0		126	100.0

Hair Form	Negro		White	
	No.	%	No.	%
Straight	—	—	2	1.6
Low waves	—	—	37	29.4
Deep waves	—	—	85	67.5
Curly	21	16.7	2	1.6
Frizzly	105	83.3	—	—
	126	100.0	126	100.0

Nose Shape		Negro		White	
		No.	%	No.	%
Elevation	Slight	94	74.6	7	5.6
	Medium	31	24.6	111	88.1
	Marked	1	.8	8	6.3
		126	100.0	126	100.0
Profile	Straight	20	15.9	62	49.2
	Concave	90	71.4	39	31.0
	Convex	13	10.3	25	19.8
	Concavo-Convex	3	2.4	—	—
		126	100.0	126	100.0
Bridge	Low	94	74.6	7	5.6
	Medium	32	25.4	111	88.1
	High	—	—	8	6.3
		126	100.0	126	100.0
Thickness	Slight	—	—	7	5.6
	Medium	50	39.7	112	88.9
	Marked	76	60.3	7	5.6
		126	100.0	126	100.0

TABLE 22—*Continued*

Lip Thickness	Negro		White	
	No.	%	No.	%
Thin	—	—	3	2.4
Medium	—	—	109	86.5
Medium-Thick	14	11.1	14	11.1
Thick	74	58.7	—	—
Very thick	38	30.2	—	—
	126	100.0	126	100.0

Table 22 clearly indicates that in the white sample, concerning skin color, no individual had a von Luschan color value over 16, and 60.4 per cent of the sample fell in the value range of 13–15. Ninety-six and nine-tenths per cent had a low wave to deep wave hair form. Approximately 88 per cent had a medium elevation, bridge, and thickness, or width to the nose. Eighty-six and five-tenths per cent had a medium lip thickness.

In the negro sample, concerning skin color, no individual had a value less than 20, and 58.7 per cent of the sample fell in the value range of 24–26. Eighty-three and three-tenths per cent had a frizzly hair form. Over 70 per cent had a slight elevation, concave profile, and low bridge to the nose, while 60.3 per cent had a markedly thick or wide nose. Eighty-eight and nine-tenths per cent had a thick to very thick lip thickness.

Unfortunately, owing to various circumstances, ABO gene frequencies were obtained on only 30 per cent of each sample and Rh gene frequencies on only 20 per cent of each sample. Since this constitutes too small a proportion of each sample the results could easily be biased and therefore are not given here.

However, my colleague Thieme has calculated the ABO and Rh gene frequencies for each ethnic group of the main Puerto Rican sample, using the formulae of Wiener [8] and Wiener and Sonn.[9]

These results are shown in table 23. As Thieme states,[10] "If it is recalled that the lower ethnic group numbers are the White end of the range and the higher numbers Negro, the changes in gene frequencies in both the ABO and Rh show

[8] Wiener, A. S., *Blood groups and transfusion*, 215. Springfield, Charles C Thomas Co., 1943.

[9] Wiener, A. S., and E. B. Sonn, The Rh series of genes, with special reference to nomenclature, *Ann. N. Y. Acad. Sci.* **46**: 969–992, 1946.

[10] Thieme, *op. cit.*

TABLE 23

ABO Blood Group Gene Frequencies for 8 Ethnic Groups of Puerto Rico

Ethnic group	Gene					Deviation from 100%	S.E.$_D$	D/σ
	I^0	I^{A1}	I^{A2}	I^B	Total			
1	.704	.156	.074	.067	1.001	.001	.013	.077
2	.377	.147	.068	.050	1.002	.002	.003	.667
3	.739	.151	.061	.050	1.001	.001	.002	.500
4	.719	.147	.062	.076	1.004	.004	.005	.800
5	.726	.118	.045	.106	.995	.005	.009	.556
6	.748	.103	.057	.095	1.003	.003	.008	.375
7	.731	.088	.065	.113	.997	.003	.011	.273
8	.740	.058	.047	.146	.991	.009	.016	.563
Totals	.735	.143	.062	.062	1.002	.002	.002	

The Rh Gene Frequencies for 8 Ethnic Groups of Puerto Rico

Ethnic group	Rh Gene							Deviation from 100%	S.E.$_D$	D/σ
	r	r′	r″	R^0	R^1	R^2	Total			
1	.2182	.0000	.0000	.0903	.5366	.1543	.9994	.0006	.0355	.017
2	.3022	.0050	.0128	.1361	.3881	.1494	.9936	.0064	.0099	.646
3	.2955	.0190	.0103	.1412	.3850	.1349	.9859	.0141	.0072	1.958
4	.2992	.0295	.0000	.2200	.3206	.1266	.9979	.0021	.0110	.191
5	.3102	.0295	.0000	.2700	.2943	.0849	.9889	.0111	.0146	.760
6	.3162	.0662	.0000	.2786	.2547	.0902	1.0059	.0059	.0134	.440
7	.2454	.0233	.0000	.3250	.2350	.1901	1.0188	.0188	.0222	.847
8	.3581	.0341	.0000	.2621	.2227	.1136	.9906	.0094	.0238	.395
Totals	.2956	.0202	.0079	.1729	.3605	.1336	.9907	.0093	.0147	

gradients which would be expected. In particular, the gradients for R^0 and for I^{A1} and I^B show expected slopes."

Since I was the member of the research team who evaluated the morphological characteristics and hence assigned an individual to an "ethnic factor" of 0–9, and since, as stated above, all individuals in the white sample fell into ethnic groups 1–3, and all individuals in the negro sample fell into ethnic groups 6–8, therefore, by inference, had the gene frequencies been obtainable for every individual in both samples, the results would probably have approximated those shown in table 23.

Once again such evidence as has been presented here for the racial homogeneity of both samples is not discernible in other existent negro-white blood pressure comparisons.

D. CONTROL OF VARIABLES POSSIBLY AFFECTING BLOOD PRESSURE IN THE SAMPLES

When the negro-white comparison was originally designed each sample was to have had 200 individuals. Accordingly 200 individuals for each sample were obtained. Upon subsequent analysis of these samples it was discovered that in each sample the majority of individuals belonged to nutritional class 2 rather than 3, but much more important, the proportion of the weight groups was not similar. Therefore, the decision was made to use in each sample only those belonging to nutritional class 2, and of these the proportion falling into each weight group had to be the same. The latter was accomplished by random sorting with the result that each sample finally had a total of 126 individuals. The percentage proportion of the weight groups is shown in table 24.

As has been already mentioned, of these 126 individuals, 84 were non-prisoners and 42 prisoners. As can be seen in table 24, in regard to weight groups in each sample, the proportions are the same for non-prisoners and prisoners. The same is true for the age groups.

In addition to the above variables each individual in each sample belonged, as already mentioned, to nutritional class 2, came from the same

TABLE 24

COMPOSITION OF NEGRO AND WHITE SAMPLES

		Negro			White		
No.		126			126		
Av. Age		28.5			28.0		
% Lt.-Wt.		5.6			5.6		
% Med.-Wt.		86.5			86.5		
% Hy.-Wt.		7.9			7.9		
Av. Ht./$\sqrt[3]{\text{Wt.}}$		12.91±.04			12.85±.04		
Systolic Mean±S.E.		116.28±1.33			117.29±1.29		
Diastolic Mean±S.E.		73.03±1.18			71.35± .91		
Systolic Range		68–160			82–154		
Diastolic Range		38–118			44–98		
Ages		18–29	30–39	40–49	18–29	30–39	40–49
Lt.-Wt.	Prison	—	—	—	—	—	—
	Non-Prison	6	1	—	6	1	—
Med.-Wt.	Prison	23	11	1	23	11	1
	Non-Prison	45	20	9	45	20	9
Hy.-Wt.	Prison	6	1	—	6	1	—
	Non-Prison	—	1	2	—	1	2
Totals		80	34	12	80	34	12

climatological region where he had lived all his life—whether in prison or not, since all the prisons in question are also in the same Region 2—was from a rural area, and finally had been or was the equivalent of a hard laborer.

In summary then, each sample was in effect matched for the following variables: (1) Nutritional class, climatological region, rural residence, and socio-economic group, i.e., hard laborer. (2) Age, weight groups, non-prison and prison.

Undoubtedly this is the first time that a negro-white blood pressure comparison has been made using negro and white samples that are indeed comparable at the outset from the point of view of the above variables.

E. BLOOD PRESSURE ANALYSIS OF THE NEGRO AND WHITE SAMPLES

Since one is dealing in this case with samples equated for a number of variables the correct statistical test to be used is once again that for matched samples. The systolic and diastolic blood pressure analysis will be given in detail.

As has been stated before, concerning matched samples, let $M_{D\,sys}$ and $M_{D\,dias}$ equal the mean systolic and diastolic difference. Also let $\sigma_{D\,sys}$ and $\sigma_{D\,dias}$ represent the standard deviation of the systolic and diastolic difference, and let $\sigma_{MD\,sys}$ and $\sigma_{MD\,dias}$ represent the standard error of the mean systolic and diastolic difference, which equals $\sigma_{D\,sys}/\sqrt{N}$ and $\sigma_{D\,dias}/\sqrt{N}$. t_{sys} and t_{dias} are then found by $M_{D\,sys}/\sigma_{MD\,sys}$ and $M_{D\,dias}/\sigma_{MD\,dias}$.

The calculations are as follows: $M_{D\,sys} = .928$ and $M_{D\,dias} = 1.682$, $\sigma_{D\,sys} = \sqrt{432.55 - .86} = 20.77$ and $\sigma_{D\,dias} = \sqrt{251.78 - 2.82} = 15.77$. Therefore $\sigma_{MD\,sys} = 20.77/\sqrt{126} = 1.851$ and $\sigma_{MD\,dias} = 15.77/\sqrt{126} = 1.406$. Finally $t_{sys} = .928/1.851 = .501$ and $t_{dias} = 1.682/1.406 = 1.196$.

The distribution of t table shows for .501 a probability of greater than .6, i.e., $P > .6$, and for 1.196 a probability greater than .2, i.e., $P > .2$.

If one employs the sign test as described by Dixon and Massey,[11] in each weight group for non-prisoners or prisoners, only the non-prisoners medium-weight group, ages 30–39, systolic pressure is significant at the *5 per cent* level of confidence.

Once again I am well aware of the composite nature of weight, and that negroes and whites probably show fat-muscle tissue differences which may affect weight, and hence in a subtle fashion blood pressures. However, for the methodological purposes of this study, particularly in view of the nutritional picture in Puerto Rico, it has been necessary to control weight, as a whole, in matched-pair comparisons.

Using the 1 per cent level of confidence then as has been done throughout this study, one may conclude, therefore, that as far as these specific Puerto Rican negro and white samples are concerned, *no significant difference is discernible in either systolic or diastolic blood pressures.*

In regard to Puerto Rico then, the above analysis answers the basic question asked at the beginning of this study, namely, are there actual racial differences in blood pressure, or are the observed differences due to lack of control of such variables as age, nutrition or climate?

Finally, it should now be clear that a methodology that neglects significant variables or distorts them is likely to lead to error. The methodology used in this study seeks to avoid these faults by a careful consideration of sample structure and the analysis of significant variables. The results set forth here seem to confirm the validity of the methods adopted in this investigation.

[11] Dixon, W. J., and F. R. Massey, *Introduction to statistical analysis,* 247, New York, McGraw-Hill Book Co., Inc., 1951.

PART IV. GENERAL SUMMARY AND CONCLUSIONS

This study has been concerned with a general critique of the methodology used in blood pressure studies, particularly racial ones.

In Part I, using a Puerto Rican sample, it has been shown that in any blood pressure study the basic step is to obtain a representative sample. Having obtained such a sample then one has to analyze the blood pressure results particularly in regard to such variables as sex, age, and weight groups. In addition, such possibly important variables as urban or rural life, nutritional class, climate, and intestinal parasitic infestation should not be overlooked.

Part II has dealt with the types of existent racial blood pressure studies; with general examples of the poor methodology to be found in such studies; and in conclusion a methodology was proposed for determining the possible existence of racial blood pressure differences. The latter methodology indicated that in racial blood pressure studies one must observe the following:

1. The samples used must be representative of the racial groups in question.

2. Some proof must be given of the relative homogeneity of each racial group.

3. Each racial group should be equated on the basis of a number of variables, the most important of which are probably weight groups and age.

In Part III, following the methodology proposed in Part II, two Puerto Rican male racial samples, negro and white, were compared for any possible blood pressure differences. The results of this comparison showed that, in regard to these specific negro and white samples, neither the systolic nor diastolic blood pressures were significantly different.

Finally, the important lesson to be learned from the results of this study is that valid conclusions regarding the effect of race on blood pressure can only be drawn from investigations that are properly controlled and analyzed by critical methods.

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